PRACTICAL COURSE IN

Modern Locksmithing

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PRACTICAL COURSE IN MODERN LOCKSMITHING

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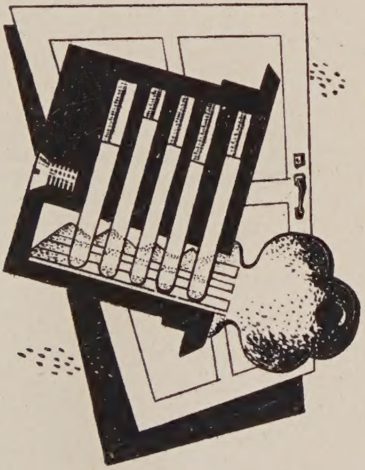

1952

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DEDICATION

To the Master Locksmiths
Of Yesterday and Today
Whose Industry and Skill
Have Set a High Standard
for the
Craftsmen of Tomorrow

This One
0CB3-5LA-E9XW

AUTHOR'S PREFACE

It is surprising, in view of today's stress on things mechanical, how little the handy-man and the mechanic in related trades know about locks.

When the publishers suggested this work I felt I might be merely going over familiar ground —bringing up-to-date what had already been well treated in book form. But a great deal of digging failed to reveal any single, systematized treatment of locks and locksmithing written in plain everyday language.

So I had to start fresh, right in my own shop. And I am now offering you new instructions on modern locksmithing written entirely out of my practical experience in the trade.

All explanations and descriptions are made as simple as possible. Throughout the writing of this manuscript I have tried to imagine the reader standing beside me at my bench. I have written just as I would talk; and I have tried to anticipate your questions.

No book alone can make an "expert." But if the following pages **start** you doing independent work—start you on the road to proficiency—I shall feel these instructions have been successful.

WHITCOMB CRICHTON

May, 1943

ACKNOWLEDGEMENTS

Many of the illustrations contained in this book have been furnished by and are used with the generous permission of leading manufacturers of locks and hardware in the United States. The author wishes to thank especially the following firms for their kind and helpful aid in making available the services of their art departments and engineering staffs.

Corbin Cabinet Lock Co., New Britain, Conn.
Independent Lock Co., Fitchburg, Mass.
Penn Hardware Co., Reading, Pa.
Schlage Lock Co., San Francisco, Cal.
Yale and Towne Manufacturing Co.,
Stamford, Conn.

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Please let me know if we can help you in your search for new fields to conquer. We enjoy meeting thirsty, elastic, active minds. It stimulates us and we may be able to do you some good, too!

V. Peter Ferrara, Editor
Nelson-Hall Co., Publishers
Chicago, Ill., U.S.A.

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INTRODUCTION

A thousand years from now History might well record the fact that all people of these modern times had one thing in common — everyone carried keys. Poor or rich . . . man or woman . . . young or old . . . city dweller or farmer. It makes no difference — keys are definitely part of us.

* * *

This situation is interesting to think about . . . but it is something else, too. It is an unusual opportunity for the young man looking for a growing, modern trade or business.

Locks and keys are used everywhere, all the time, by nearly everyone. Locks need careful selection . . . they need wise installation . . . they have to be properly serviced to keep in good working order . . . they have to be repaired . . . and they have to be replaced.

In many communities this specialized work by itself makes a profitable full time business.

Locksmithing is more than commonly well suited for spare time work also. A knowledge of locks and keys can prove a side-line that is both profitable and pleasant. The handy-man locksmith in any community might be one of its most valuable workers.

There is unquestionably a lot of lock work. Just think about your own surroundings for a moment. Your car has at least three locks, and more keys . . . your home has two or more outside doors, each probably containing more than one lock . . . and the inside doors with simpler locks . . . and the desks, chests of drawers, cabinets, cedar chests, tool kits, etc., etc. . . . in truth, it might be said we live our lives according to the laws of the lock and key.

INTRODUCTION

Around the factory, the office, the shop . . . there's practically no end of locks and keys.

* * *

Since locks enter into so many different phases of life an up-to-date knowledge of locksmithing is valuable to workers in many lines. Certainly carpenters should know about locks. This might not strictly be their responsibility . . . but they are better carpenters for knowing how to avoid damage to locks . . . and for knowing how to make minor adjustments and repairs.

Automobile mechanics and service station attendants often come face to face with ticklish lock problems. Building maintenance men and engineers in many lines are sometimes called upon to do emergency lock work. This takes native ingenuity . . . but this "horse sense" must be seasoned with a little technical knowledge of locksmithing.

And any man who claims membership in the army of Home-Mechanics is not worthy of this great position if he cannot tinker — intelligently — with common locks and keys.

* * *

All this practical, down-to-earth talk leaves untouched that vast realm where the lock and the key have mystical qualities . . . fascination that is more than mere utilitarian. They are symbols, magicians use them to make audiences gasp, collectors travel half the way around the world and spend enormous sums for locks and keys.

HOW TO STUDY THIS COURSE

Reading for information is done in quite a different way from reading for relaxation. Story-reading not only does not take effort but it releases tension and calms tired muscles and brains.

Reading-with-a-purpose, on the other hand, takes engine power. Unless you drive yourself . . . unless you "tear the heart out of the book" . . . unless you are tired after your study period you have not received full benefit, and you are cheating yourself.

* * *

The following lessons make up a "course." They are to be studied . . . read slowly and with an alert mind. Studying a course is very much like reading a text book, except that you are expected to DO something besides read.

In order to cover this Locksmithing Course properly you should work on actual locks. You probably have a suitable work bench and most of the tools needed. The few special tools can be home-made, if you have the time.

Get at least one of each common lock mentioned in this course. They need not be brand new as long as they are in fair working order.

As you come to statements about these locks look yours over . . . notice its outside shape . . . notice the kind of metal. Work it until you learn its operation. After this take it apart slowly, studying each part, each screw. Find out "what makes it tick."

Illustrations in these lessons are the best obtainable . . . but no picture is 100 per cent satisfactory.

* * *

You will find the following lessons orderly arranged, logical, and easy to understand. Do not let this tempt you to go too fast. Remember, **your success is measured by the information you master** — not by the speed with which you turn the pages.

Make haste slowly. Study a short period every day. Here is an interesting fact Nelson-

Hall's wide experience in the home-study field has brought out. After furnishing self-teaching instructional matter to more than 100,000 students and watching their results we find that long study periods are not efficient.

Thirty minutes concentration each day for six days teaches you far more than one three-hour study session.

* * *

When you start work on this course begin with lesson No. 1. It is best to take the lessons as they are presented because they are arranged in their order of difficulty. One lesson leads naturally into the next.

Spend considerable time on the glossary. This is one of the most important sections of the course. Study the definitions and the illustrations referred to in these definitions. Know the meaning of each word or term before you pass on to the next. Review often.

If you get the opportunity to put your knowledge to actual test while you are studying jump at the chance. You not only may earn some money — but you learn faster by putting into practice what you read.

During the day pay particular attention to the various kinds of locks you see. Notice for what purpose they are used . . . notice how they are installed. You'll see locks everywhere . . . on your bus . . . in your shop . . . on your suitcase . . . in the stores . . . theatres . . . banks, etc,

* * *

Use a lot of pencil and paper. Make notes as you study. Remind yourself to check up on a certain kind of lock. Draw rough diagrams to help fix important facts in mind.

All information on locks should be collected and filed. Other text books might contain a few statements, magazines might have "human interest" stories about locks. Such information may be jotted down in the back of this volume. There are a few blank pages for "SELF-HELP NOTES."

SECTION I

HISTORICAL BACKGROUND

Very early in the history of the human race, primitive man developed the theory of private ownership. The cave dweller who buried his extra food was probably the first to realize that in order to maintain possession he must guard his property. He soon found, however, that neither secrecy nor strength in themselves gave adequate protection.

1. EARLY DEVELOPMENT

But it was not until many centuries later, during the Metal Age, that any device resembling our present day lock made its appearance. As early as 2000 B. C. a crude sort of arrangement was invented by the Egyptians. This early attempt at security consisted of a heavy wooden boltwork actuated by a large metal key.

Ornate and exquisitely decorated keys were very common during the middle ages, with craftsmen seeming to sacrifice utility for artistry. The first impetus toward a general reformation in lock construction came, however, as a result of the inconvenient large size and great weight of these keys, rather than because of lack of security in the locks. At any rate, the combination or puzzle lock made its appearance in the early sixteenth century. But even as late as 1825 the key to an ordinary household chest in this country weighed considerably more than a pound.

2. THE UTILITARIAN PERIOD

Really noticeable improvements in lock structure and security were not forthcoming until the nineteenth century. Probably the greatest incentive for producing a better lock was the English lock controversy in 1851, when the American expert A. C. Hobbs succeeded in picking the finest and most expensive locks produced by the leading British and Continental manufacturers. A Birmingham writer, commenting on the incident in 1878 said, "The principle of the Bramah lock appeared so perfect and unassailable, that for 50 years a padlock . . . hung in the shop window of a firm in Piccadilly with a board attached, on which was inscribed, 'The artist who can make an instrument to pick this lock shall receive 200 guineas the moment it is produced'."

This was the lock Hobbs succeeded in opening. Another early American locksmith was James Sargent who delighted in making severe tests of all available locks. When he found that he could pick every one then on the market, he set about designing a lock which he **could not** pick — and after exhaustive experiments he succeeded. In the meantime, other manufacturers had improved their products and developed new types. One of Sargent's contemporaries, Linus Yale, Sr., skillfully developed the principle of pin tumbler locks from early Egyptian beginnings, but Yale, too, succeeded in picking even these. Realizing at last that any lock with a keyhole could never be made to withstand picking attempts by an expert, he turned to the combination lock.

About that time Sargent had succeeded in proving to the treasury officials that he could pick combination locks, even those on the United States treasury. Then Linus Yale, Junior, took up his father's work and these two American locksmiths, although working separately and individually, developed the first really secure locks known to mankind. Sargent is famous for his invention of the time lock for banks and Yale for simplifying the combination lock and producing a compact cylinder lock for general use.

3. PRESENT DAY DEVELOPMENTS

The underlying principles of lock engineering **have not** changed materially in the past 200 years, although constant improvements are being made and new ideas developed. Practically all the leading lock manufacturers of the present time maintain large engineering staffs. These experts check not only their own products but also those of their competitors. Not so long ago one of the engineers noticed another firm advertising a "pickproof" lock cylinder. He investigated, decided it was pick **resistant** but not **proof.** A complaint to the Federal Trade Commission brought a call for experts to pick it. After someone succeeded in opening it, its manufacturer was warned by the federal government that he could no longer advertise it as **pickproof.**

And so it goes — modern lock design is a continual race to keep ahead of the competition. Every time someone develops a better lock, another expert finds a way to open it. Present day locks are, however, considered as safe as the theory of practicability allows. Secure locks are available at competitive prices, and better locks, if they are required, could be produced, but at a cost higher than their probable utilitarian value. Such modern developments as parking meters, vending machines, and telephone coin boxes illustrate this point. These devices must have protection from ordinary attack **at a cost certainly not to exceed the value of the money or property protected.**

SECTION II

INTRODUCTION TO THE TRADE

Every profession has a language of its own. The locksmith, although not concerned with formulas and symbols, has a large number of technical terms peculiar to his business alone. These standardized expressions are particularly helpful in reading and understanding lock and key catalogs, in making up orders for parts and in studying service instructions issued by the various manufacturers.

On the following pages you will find listed the common words, phrases, definitions and miscellaneous terminology used by locksmiths. Where a definition is followed by a page or illustration number, you are referred to a cut-open or sectional drawing that may be helpful in understanding the particular application of the term.

4. GLOSSARY OF TERMS PERTAINING TO LOCKS AND LOCKSMITHING

anti-pick latch—(see deadlatch) a springlatch protected from end pressure to prevent jimmying the door with a knife blade or similar object. (See Illustration No. 66)

armored front—an extra cover plate supplied on some mortise cylinder locks to conceal the cylinder set screws and prohibit tampering with or removal of the cylinders.

back plate—on a rim nightlatch, the plate through which the connecting screws are fastened into the cylinder. When these screws are tightened from the back of the door before the lock case is screwed on, the cylinder is held securely in position.

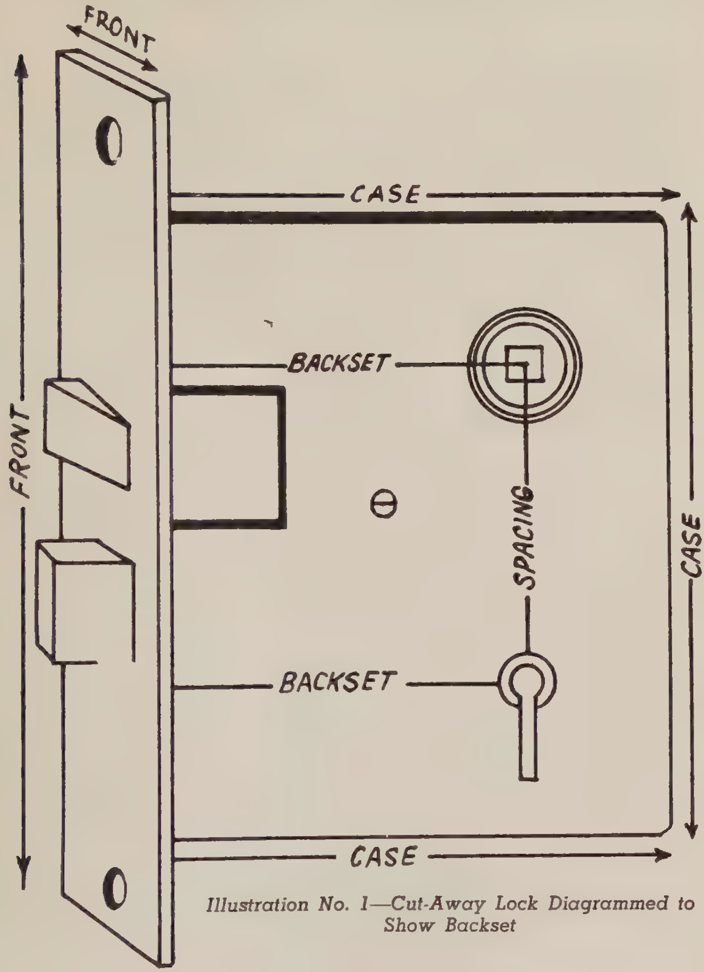


Illustration No. 1—Cut-Away Lock Diagrammed to Show Backset

backset—in any lock, the horizontal distance from the face (edge of door) to the center of the keyhole, spindle hole or cylinder hole. (See Illustration No. 1)

barrel key—a type of key in which a hole is drilled in the end to fit over a post or stud in the lock. Sometimes called a hollow post key. Used most often on trunks, suitcases and railroad padlocks. (See Illustration No. 2)

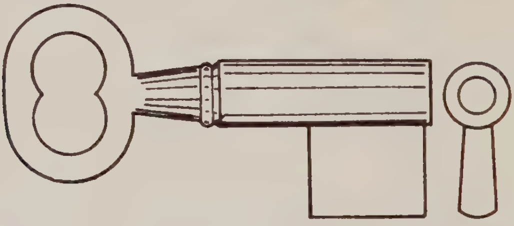


Illustration No. 2—Barrel Key, Known Also as Hollow Post Key

bevel—with regard to doors, **reverse bevel** or **regular bevel,** depending upon whether the door swings out—toward the side the key is used from—or in— away from where the key is used. (See Illustrations No. 3 and No. 4) **Hand** and **bevel** are related terms used together to specify requirements for locks; as for instance, right hand regular bevel, or left hand reverse bevel.

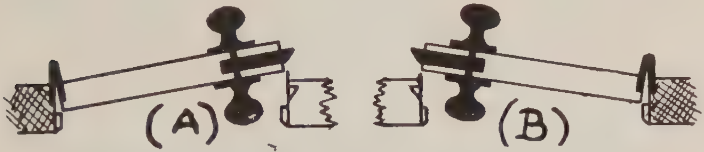


Illustration No. 3—Doors Opening In. Left Hand, Regular Bevel. Right Hand, Regular Bevel

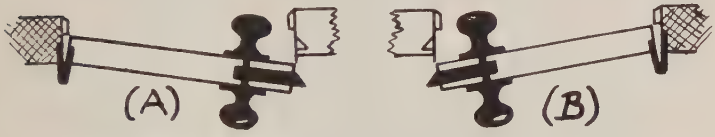


Illustration No. 4—Doors Opening Out. Left Hand, Reversed Bevel. Right Hand Reversed Bevel

bicentric cylinder—a special style of pin tumbler cylinder, used in large master keyed installations, in which there are two keyholes, one for the change key, and the other for the master key. (See Illustration No. 5)

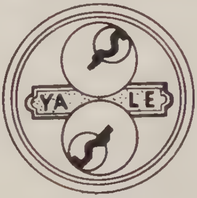


Illustration No. 5—The Yale Bicentric Cylinder

bit—that part of a bit key against which the lock tumblers operate.

bitting—the arrangement of the combination of a bit key—the way the depths of the cuts for the tumblers are designed. (See Illustration No. 64)

bit key lock—a lock in which operation of the bolt depends on setting of the tumblers by a bit key, revolving around a fixed point.

blank—(key blank) an uncut key. Any unfinished key as it comes from the manufacturer before any cuts have been made in it to fit the tumblers of any particular lock.

bolt—the sliding member of a lock which locks or unlocks the door by moving back and forth in the lock from a flush to an extended, or locked, position.

bow—(pronounced bo) the handle, or head of a key.

burglar proof—intended to be absolutely safe against unauthorized entry by any person, however skilled.

burglar resistant—intended to **resist** ordinary attack by prowlers, thieves, or robbers. A **burglar resistant** lock should slow a burglar down, while a **burglar proof** lock should stop him.

butcher—(locksmith's slang) any one, inside or outside the trade, who by ignorance, inexperience or poor craftsmanship injures or destroys a lock or locking device in crude attempts to open it, when skillful methods should have been used to make a **clean opening.** Also, any sloppy workman.

cam—(lock cam) an arrangement fitted to the cylinder hole of a mortise lock to equip it with a thumb turn so as to provide easy operation from one side of the door. Used widely on the inside of front door locks on residences. (See Illustration No. 51)

cam—(cylinder cam) the end piece on a mortise cylinder, screwed to the plug, which actuates the bolt as the key revolves.

cam—(cloverleaf or cog action) a special shaped cylinder cam used on recent Russwin cylinder locks. Not transferable with ordinary cylinder cams.

case screw—(cover screw) a screw which holds the cover of a lock on, consequently holding the lock together.

case ward—in bit key locks, a ward cast or fastened into the lock case, requiring a ward cut to be filed in the sides of the key. (See Section IV)

change key—(also known as **tenant's key, guest key, occupant's key, operating key, individual key** and **room key.** A key which fits only one given lock, as in a hotel or office building.

clean opening—the locksmith's description of a skillful unlocking job, as in opening a safe without drilling the door or using force.

code—an arrangement of ciphers or letters, enabling keys to be made or duplicated by qualified persons without samples.

cog action cam—see cam, cloverleaf.

collar, cylinder—(also called cylinder ring) a metal ring placed under a lock cylinder to make a tight fit between the door surface and the face of the cylinder. Sometimes these are adjustable, and are then known as spring rings.

combination lock—any lock depending for its operation on the setting in a proper sequence of certain pre-determined numbers on a revolving dial or dial ring.

connecting bar—on a rim nightlatch, the bar connecting the cylinder plug to the lock case.

connecting screw—in a rim night latch, the screws (two are used) which go through the **backplate** to hold the cylinder in place.

control key—with reference to "Best" interchangeable core cylinder locks, the key which permits the removal of the lock core. Also known to the trade as the **guard key** or **core key.**

core—with reference to "Best" interchangeable core cylinder locks, the removable portion of the cylinder, known as the core, and consisting of the plug, pins, drivers, and an extra sleeve for holding the whole assembly in the lock.

corrugated key—an early type of cylinder key, stamped out of metal, as distinguished from present day keys, which are milled, or cut, not stamped. This term has now come to refer to any stamped key, consequently most often used with reference to cheaper locks, as warded padlocks.

crushable disc tumbler—a special type of disc tumbler introduced during the high point of disc tumbler popularity to overcome the necessity of carrying several sizes of tumblers in stock. (See Section VI)

cuts—the indentations made in a key to make it fit the lock. Any notch filed in a key is known as a cut, whether it is square or rounded.

cylinder—a removable unit on high grade locks which contains the tumblers and receives the key, which when turned, operates the lock.

cylinder dummy—a plate, made to resemble the face of a cylinder, for installation on, for instance, double doors, where a real lock is installed on one and it is desired to keep the doors balanced in appearance.

cylinder set screw—in mortise locks, the set screw, put in from the face of the lock (edge of the door) which holds the cylinder rigidly in place. (See Illustration No. 47)

cylinder ring—see **collar, cylinder.**

dead bolt—a lock bolt which is actuated only by the key, is square on all edges, and has no spring behind it. The key cannot be withdrawn from the lock unless the bolt is either fully extended or withdrawn. (See Illustration No. 46)

dead latch—(also called anti-pick latch) a type of spring bolt protected by a device which automatically "kills" the spring after the door has sprung shut, preventing jimmying of the bolt from the outside by burglars.

depth key—(also called guide key) any key in a set of sample keys furnished with a code to enable a locksmith to cut keys from number alone.

derivative code—a lock code in which there is a close relationship between the lock number and the cuts in the key. (See Section IX)

dial lock—any combination lock, usually a light one.

disc tumbler—a flat, stamped tumbler used in medium and low priced cylinder locks. (See Section VI)

display key—a special shut-out key used to lock a hotel room where valuable merchandise or samples are on display. (See Section VIII)

door check—a door closer. A spring device to close a door automatically after it is opened; usually equipped with a checking valve to retard the action of the spring and close the door slowly and quietly.

double custody lock—any lock requiring two keys or the cooperation of two persons to effect an opening.

drive proof spindle—see spindle, drive proof.

driving tumbler—in a safe lock, the tumbler which is fastened to the spindle, and which rotates the other tumblers by "picking them up" with pegs or studs. (See Section X)

dummy cylinder—see cylinder, dummy.

electric latch release—an electrically operated strike, used where a door must be opened from within the premises by remote control, as in apartment houses and on office gates. Pressing a button causes the elctromagnetic coil to draw a bar, releasing the strike so the door can be opened without a key.

electric strike—see electric latch release.

emergency key—any key used only in case of emergency; especially a key kept by a hotel or apartment manager to unlock doors locked from the inside, as in cases of sickness or suicide. (See Section VIII)

end ward—a ward cut made in the end of a bit key.

escutcheon, also **escutcheon plate**—the trim or plate fitted on each side of the door to conceal the holes bored for a mortise lock and to support the door knobs. (See Illustration No. 52)

fence—in a combination lock, the gravity operated plunger that falls into place when the tumblers are set to the proper combination.

fence slot—the U shaped cut made in each tumbler in a combination lock.

following tool, or **follower**—a tube or rod used in dissassembling pin tumbler lock cylinders to keep the upper pins and tumbler springs in position while the plug is removed, as, for instance, to change the key combination. (See Sections III and VI)

gate—in a lever lock, the narrow passage on the lock bolt through which the **post** must pass to operate the lock when the tumblers are set with the proper key. (See Section V)

geared drive—a feature of many high grade combination safe and vault locks, providing for the tumblers to be driven by an offset gear connected to the spindle.

genuine key blank—known as a "genuine". Any key blank, especially a cylinder blank, made by the maker of the lock for which it is intended. Preferred by locksmiths because they generally fit better than imitations or "counterfeits" of other manufacturers.

grand master key—a master key controlling all the locks in a building or group of buildings, as distinguished from a floor master or maid's key.

graphite gun—an air gun for squirting powdered graphite into key holes.

guest key—see **change key.**

hand—the **hand** of a door is determined, as in illustrations No. 3 and No. 4 to be either right or left, depending upon which side the door is hinged. Many heavy duty locks are "handed"; that is, they cannot be reversed. They must be ordered for doors swinging one way or the other, and cannot be used on doors swung from the other side.

hasp—any device for attaching a padlock to a door. Usually consists of a slotted hinged flap closing over an eye.

hollow post key—see barrel key.

keyway—the design or shape of a keyhole; in pin tumbler locks, the cross sectional outline of the keyhole, hence the shape of the key.

hotel lock—a lock intended for use on a hotel or apartment, providing a means of locking from the inside that shuts out all keys except the emergency key.

individual key—see change key.

indirect or **offset drive**—see geared drive.

key—any small metallic instrument intended for setting tumblers or operating a lock.

keyhole lock—an insert for use with bit key locks, consisting of a tiny pin tumbler lock which plugs the keyhole against unauthorized keys, giving additional security.

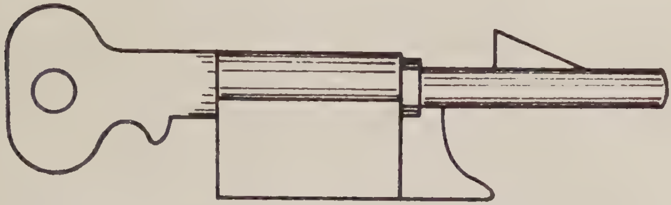


Illustration No. 6—A Keyhole Lock

key blank—see blank key.

key caliper—a small caliper used for measuring the depths of tumbler cuts made in a key. (See Illustration No. 15)

key check or **key tag**—a metal or fibre disc attached to a key, usually with a number inscribed, to make identification easy, as in hotels.

key machine—a mechanical contrivance for accurately duplicating keys. Generally motor driven, and adjustable for various styles of keys. (See Illustration No. 14)

knob screw—a short oval headed machine screw, used to fasten door knobs to the spindle.

knob washer—a washer put on under a door knob to compensate for variation in door thickness, to keep knobs from rattling.

latch—that part of a lock which, because of a spring device behind it, slides in and then springs out to keep a door in position when it is closed.

laying out board—a board or tray for setting pins in while working on a lock to prevent their becoming confused. (See Section III)

lever tumbler—a lock tumbler principled after the lever, in that the key acts against a spring with a force to move the tumbler on its pivot until the lock can be opened. (See Section V)

lock—a device for securing a door in a closed position until a key is used to actuate boltwork and thereby release the fastening.

lock code—see code.

lock post—the pivot on which lever tumblers move.

lock trim—this term covers everything ordinarily included in a lock set, particularly the door knob and escutcheon plates or rosettes.

maid's key—a sub-master key, or floor key; a key set to operate a limited number of master keyed locks, each of which is also operated by an individual **change key.**

mail box lock—a special type of light lever tumbler lock intended for use on apartment house mail boxes, or other places where circumstances require a lock that cannot be left unlocked. The key to this type of lock cannot be withdrawn except with the bolt in the locked position.

master disc—in pin tumbler locks, a short disc inserted to bring a tumbler to the "breaking point" when the master key is inserted. (See Section VIII)

master key—a key controlling a number of locks, each of which is also controlled by its own individual key.

master key collar or **sleeve**—in masterkeyed Corbin cylinders, an outside auxiliary ring used over the regular plug. (See Section VIII)

milled key—a cylinder lock key stamped from a sheet of nickel silver and then grooved by a milling machine to fit the keyhole. A **corrugated key,** on the other hand, is often finished in the one stamping operation.

money chest—a burglar resistant steel depository, fitted with a stout combination lock. Usually these are securely fastened inside a larger fireproof safe or vault.

mortise lock—any lock which is recessed into the door, for which cutting must be done to install the lock. See also **rim lock.**

mortise strike—a strike plate intended for use with a mortise lock. Cylinder night latches, for instance, usually come equipped with mortise and surface strikes for use on regular bevel or reverse bevel doors.

multiple custody lock—see double custody lock. Any lock the security of which depends on two or more separate keys or combinations, all of which must be used at one time to gain entry. See **safe deposit lock.**

neck—that part of the stem of a bit key between the **shoulder** and the **bit.** This varies on different locks with the thickness of the lock case. (See Illustration No. 11)

nickel silver — the material from which high grade cylinder key blanks are made. When there is no metal shortage, federal specifications call for 65% copper, 20% nickel, 4% tin, 5% lead and 6% zinc in this material, sometimes known as keymetal or white metal. Because of wartime shortages of tin and other metals, key blanks were for a while made of a softer brass mixture, also scarce.

occupancy indicator—a device furnished on some high grade hotel locks to tell employees at a glance whether or not a room is occupied. This feature saves guests the disturbance caused by a maid entering the room with a broom and mop only to find it occupied.

occupant's key—see change key.

operating key—see change key.

padlock—a portable lock not permanently fastened to a door, usually consisting of a shackle fitting through a hasp or eye, with a lock that closes the open end of the shackle.

panic bolt—a device used on schools and public buildings which secures a door in the locked position, and yet allows instant opening by slight pressure exerted against a lever-bar on the inside, as, for instance, by people crowding toward a door in event of fire.

pass key—layman's term for pick key or master key; a skeleton key.

pin punch—a hardened tool steel punch used by locksmiths for removing case rivets from certain padlocks when combination changes are to be made. (See Illustration No. 7)

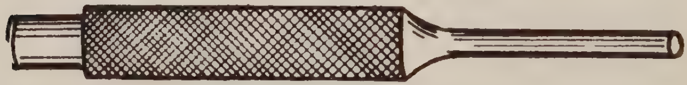


Illustration No. —A Pin Punch

pin vise—a small, portable hand vise, used to hold keys while filing them. (See Illustration No. 8)

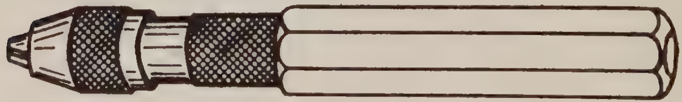


Illustration No. 8—Locksmith's Pin Vise

plug—the round core of a lock cylinder which rotates when the key is turned.

post—see lock post.

rap—to hammer or tap a cylinder to split the combination without a key. (See Section VII)

relocking device—a burglar resistant safety device on a combination lock. Damage to the main lock by force trips a trigger on an auxiliary boltwork and prevents the safe from being opened.

restricted keyway—a special keyway, as for instance, restricted to government locks. (See Section VIII)

retainer spring—in a disc tumbler cylinder, the spring ring or clip that holds the plug in place in the shell.

rim lock—as distinguished from a **mortise lock.** A **rim lock** is fastened on the surface of a door, and not cut in, except for cylinder or knob holes if necessary.

rim strike—a strike plate or cap intended for use with a rim lock.

rosette—a small round, ornamental ring, known to hardware men as a "rose" used widely in modern residences with interior latch sets instead of escutcheon plates.

safe—any heavy portable or semi-portable strongbox for the protection of valuables, usually equipped with a combination lock.

safe deposit lock—a double custody lock used on safe deposit boxes in bank vaults.

security system—a masterkeying plan in which each group of locks has a different keyway, but the master key passes all. (See Section VIII)

set up—to set up a lock is to combinate it, or to assemble the tumblers to be operated by a given key.

shell—the external case of a lock cylinder, without the **plug.**

skeleton key—a bit key with very wide ward cuts, intended to fit practically all inexpensive single lever bit key locks.

spacing—the vertical distance between the center of the keyhole and the center of the spindle hole in a mortise door lock. (See Illustration No. 1)

spindle—the rod to which door knobs are attached.

spindle, drive proof—a cone shaped or shouldered spindle used on combination locks to prevent the lock from being driven into the safe by attack from the outside.

spindle, jointed—a two piece spindle used with cylinder locks which have a handle on one side and a knob on the other. (See Illustrations No. 9 and No. 10)

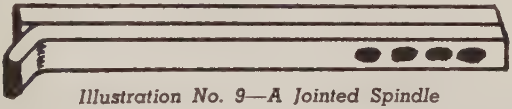


Illustration No. 9—A Jointed Spindle

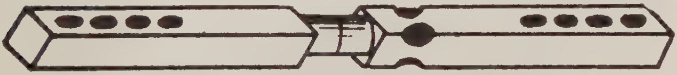


Illustration No. 10—A Swivel Spindle

spindle, swivel—a spindle which has a swivel joint in the center which allows one end of it to turn while the other half remains stationary, as in a lock equipped with a built-in night latch or stop work. (See also Illustration No. 46)

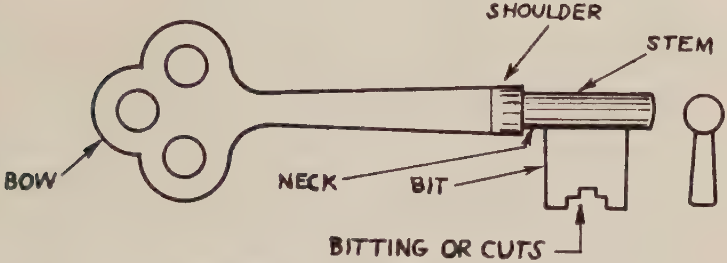
spindle, threaded—a type of spindle usually furnished with high grade locks, onto which the knobs are screwed and held in position by set screws bearing on the surface of the spindle.

"split" a combination—on a masterkeyed pin tumbler lock, to open the lock with an unauthorized key, one which sets part of the combination on the change key position and part on the master key position.

spool pins—pin tumblers used in some cylinder locks to foil picking attempts; so called because they are shaped like miniature spools. Also known as mushroom pins.

spring bolt—a lock bolt beveled on one side which springs into place automatically when a door is closed, locking it until the inside knob is turned or a key is used from the inside.

stem—part of a bit key. (See Illustration No. 11)



Illustration, No. 11—Parts of a Bit Key

stock master key—with reference to bit key locks, a standard master adopted by a particular factory, to which all locks of a certain series are set, even though they may be used in many places throughout the country.

strike—the plate recessed into the door jamb, into which a lock bolt or latch fits when the door is closed or locked.

sub-master key—see maid's key.

surface strike—see rim strike.

tail piece—see connecting bar.

tenant's key—see change key.

thimble (setting-up thimble)—a device for holding a cylinder plug in position while loading it with tumblers. (See Section III)

thread gauge—a set of gauges fitted into a handle, for determining the coarseness of machine screw threads, as in matching set screws, cover screws, etc.

thumb turn (turn knob)—on the inside of a door equipped with a cylinder lock, the "butterfly" handle, which connected to the lock cam, operates the deadbolt. (See Illustration No. 12)

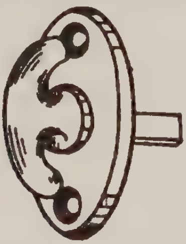


Illustration No. 12

A Thumb Turn or Turn Piece

time lock—a safe or vault lock designed to remain locked until a certain number of hours have elapsed since it was closed and set. (See Section X)

timbination lock—(See Section X)

tumbler—any movable or variable device in or attached to a lock upon which security against unauthorized entry depends.

turn piece—see **cam, lock.**

vault—a permanently located strongroom designed for the safeguarding of valuables.

vault lock—a lock suitable for use on a vault. (See Section X)

warding file—a thin file with cutting teeth on the edges, for cutting narrow slots in keys, as ward cuts in bit keys.

5. THE LOCKSMITH AS A CRAFTSMAN

The guild system of the middle ages, with its long periods of carefully supervised apprenticeship, brought about a very high standard of **craftsmanship.** In those times, no person was allowed to call himself a carpenter, a shoemaker, a shipbuilder or a locksmith until he actually was what he represented himself to be. Not until he had spent the required number of years in preparation and his masterpiece had been accepted by the guildmasters, could he engage in business in his own name. The guild system made every man proud of his own work. A person who was not interested in his work could not last out the apprenticeship, and a bungling or clumsy worker was never accepted as a journeyman or master craftsman.

Today, most crafts are not so stringently controlled. But in the case of locksmithing, the early day emphasis on quality workmanship still prevails. Intricacies in the manufacture and operation of locking devices have required even additional standards of accuracy.

A locksmith is a good craftsman not so much because of his experience or knowledge, **but because of the care with which he works.** Many a man with a good background for the trade, either from builders' hardware or related training, fails completely because his theory of doing business does not include a high ideal of craftsmanship and customer service.

All this emphasis on mechanical accuracy does not mean however, that no knowledge is required. Even a beginner must have a primary knowledge of simple construction features and standardized operations in the shop. But above all, **he must have initiative.** Even experts who have been in the business for many years are constantly having to solve new problems. The greatest asset any locksmith can have is the ability to analyze defects in operation and make careful repairs. The job itself is often simple after the source of the trouble has been discovered.

6. ETHICS OF THE TRADE

The general public hears a great deal about the ethics of a number of professions. **If there is any trade in which honesty, integrity, and a spotless reputation are vitally important, it is locksmithing.** The locksmith, in a sense, is the guardian of the internal security of the country. His work protects both business and the home. He is respected in his community.

Probably the reason we do not hear more public ballyhoo in regard to the ethical conduct of locksmiths is that no one ever questions their character. They are proud to be locksmiths, and as such, they frown upon any approach toward unethical conduct, either among their own membership, newcomers, or the general public. In all my years of practice I have yet to read or hear of a qualified master locksmith being charged with an offense against the public good. Let every beginner remember that he must be a credit to the trade and that **a single shady deal makes him a traitor** to those who have helped and encouraged him to get started in locksmithing.

7. MEETING PUBLIC CURIOSITY REGARDING THE TRADE

There has always been a certain amount of lure to the lock. Almost any normal individual is curious beyond concealment about how and why locks work. Many locksmiths are troubled by customers wanting to watch their locks being worked on.

Certainly no thinking locksmith will thoughtlessly give away all his own hard-earned experience by catering to the questions of the public. Nor does he wish to offend anyone by refusing information. Perhaps the best way to deal with this public curiosity is to divide the shop or working space into two sections. One is the front shop, or display room, where new locks, key blanks, and similar items are kept.

In the back section, screened off from the customer space, is the work bench and tool cabinet where the actual work is done. Questions can be politely ignored or some other subject brought up. If the customer insists on trying to glean information, turn on a machine; whether it's the emery wheel or key machine doesn't matter. Just pretend you can't hear him over its roar.

No surgeon tells his patients how to remove their own tonsils, nor does a lawyer tell a client more than is necessary for a successful prosecution of the case. Why should a locksmith even be expected to tell a customer how to fix his front door lock or change his safe combination?

8. GOVERNMENTAL REGULATION

In order to help legitimate locksmiths protect themselves and the public against unscrupulous or inexpert persons posing as locksmiths, many states and municipalities have enacted laws relating to the trade.

The State of Washington, for example, some years ago enacted a statute prohibiting the ownership or transportation of certain locksmithing tools, including pick keys or pass keys, **except by qualified established locksmiths.**

To protect the public against poorly fitted keys, the city of Seattle, at the insistence of a number of locksmiths, passed an ordinance requiring registration and licensing of every person cutting, fitting or duplicating keys in that locality.

Almost every community of any size requires that a license be acquired from the city for any kind of business, including the establishment of a locksmith shop.

Every person preparing for and contemplating engaging in locksmithing should carefully inquire from official local sources the requirements that he will have to meet. Individual cases differ, and it will pay to be sure before going ahead. Almost every public library has a copy of the laws and statutes of its own state compiled by subject matter, and an inquiry at the city recorder's office will bring to your attention any local ordinances affecting the subject.

These laws are designed to **discourage dishonest individuals** from entering the trade. And, by the same token, they **protect and encourage men of good reputation.** Laws like this are good.

SECTION III

TOOLS and WORKING EQUIPMENT

A locksmith, like any other skilled craftsman, needs a variety of tools to pursue his trade. He has a distinct advantage, however, in being able to produce many of these necessary tools in his own shop. Although many special tools can be purchased at fancy prices from supply houses they can just as well be fashioned in spare time from scraps and discarded parts.

9. THE WORK BENCH

The first important part of any shop is a good substantial place to work. This should be a stout table or work bench, placed where there is plenty of light from the side or from directly above, not from behind where you stand. **Daylight should be sought wherever possible.** Concentrating on minute details in artificial light is not only tiring but hard on the eyes, especially if the light is poor or not properly placed.

The bench itself should be at a convenient height. Usually just about belt level is correct. A bench too high rather than too low is to be preferred, for by standing on a false floor you can bring the work to any desired level. Nothing is so tiring as having to stoop continuously over a low bench.

A husky vise, firmly anchored near the right hand end of the bench is the next important item. If you can't afford an expensive one, try several in the stores till you find one that stays tight. Swivel vises in some cases may be convenient, but are generally frowned upon because the swivel feature removes most of the rigidity, which is an important factor.

The ideal vise is a heavy machinist's model with jaws measuring at least four inches across, and opening enough to accomodate a door check five inches thick. (See Illustration No. 13)

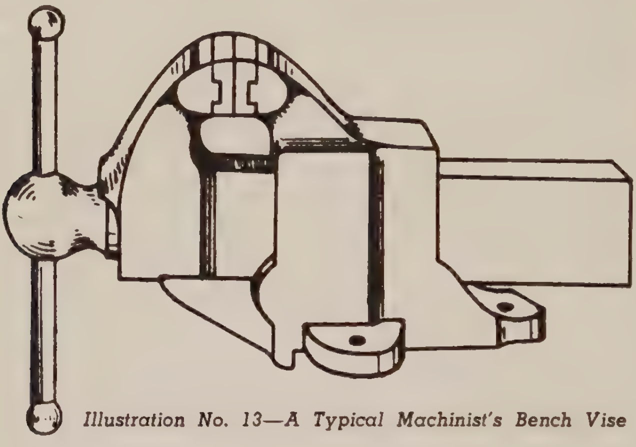


Illustration No. 13—A Typical Machinist's Bench Vise

Near the vise provide drawers or trays for all the small tools that are used at or near the vise. Try to avoid keeping more tools than necessary on the bench itself. Keep it clear for jobs being worked on and for special heavier tools being used at the moment.

Somewhere on the bench (at the far end away from the vise is a good location) arrange some cigar boxes or bread pans to hold jobs pending completion. Permanently number each of these trays, and when a customer brings in a job, give him a tag bearing the same number as the box you put his lock in. **Also put a slip of paper in the tray setting forth his service requests**—how many keys he wants, whether he wants the combination changed, etc.

It may be several hours till you can get to a particular job, and these written memos insure against costly errors and possible hard feelings.

10. SELECTING A KEY MACHINE

If you are fortunate enough to be able to see your way clear to a key machine, try to mount it somewhere on a separate table or bench. Vibrations from hammering and working at the vise will often jar such a machine out of adjustment if it is mounted on the same bench.

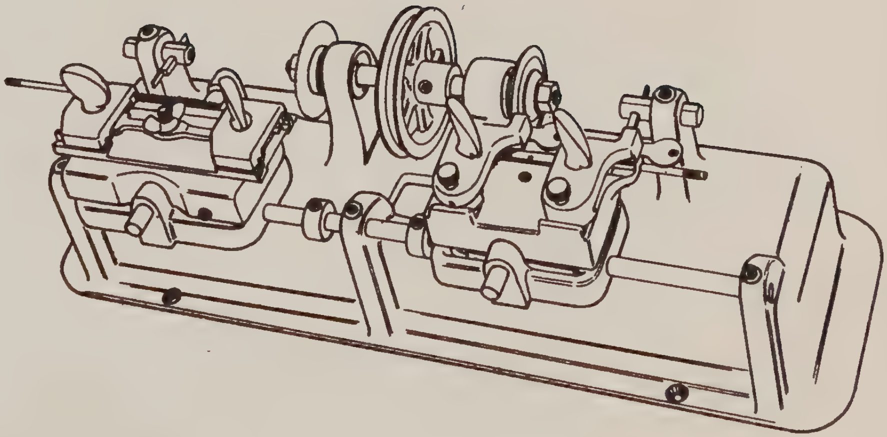


Illustration No. 14—A Key Machine (Courtesy Independent Lock Company)

The slightest inaccuracy in a key cutter is self-evident—trouble and more trouble.

In picking out a machine (if you have that choice) be sure to get one with an **adjustable or changeable vise** to accomodate all types of keys. If you anticipate cutting flat steel keys as well as nickel-silver-cylinder keys you will need two cutting wheels and two separate vises. Some machines are furnished with cutters that can be switched back and forth, but much time and effort is wasted if it is necessary to do that every time a different type of key is cut.

A typical dual purpose power-driven machine is shown in Illustration No. 14. It meets the need for an all-in-one machine capable of accurately duplicating cylinder keys, flat steel keys, and the lever cuts of bit keys without changing cutters.

In considering a used machine, especially an old hand power model that turns with a crank, remember that many of these are obsolete, that new cutting wheels cannot be secured, and that many of the earlier models had "V" shaped cutters, which make them useless for cutting close to the shoulder as is required on keys for many new locks, especially automobile equipment. Also, many of these wheels were very coarse and did not do a smooth cutting job.

A poor or inaccurate machine is almost **worse** than no machine at all. It is probably better to pass up the machine in the earliest stages of the game until you can invest in one that really takes your eye and fits your pocketbook.

11. BENCH TOOLS

Any mechanically inclined man probably has at hand **most of the simple hand tools required to get started.**. Listed below are the common tools you cannot do without.

pair wire cutting pliers
flashlight (preferably focusing type)
medium sized screwdriver
small screwdriver
file assortment, with handles:

8″ mill file
6″ mill file
6″ round file (special fine tooth)
6″ square or triangular file
4″ flat warding file
6″ flat warding file
hand drill with assorted drills up to ¼″
metal countersink bit for hand drill
16 or 20 ounce hammer, any pattern
8 or 10 ounce hammer (preferably machinist's pattern with cross pein)
hack saw with two blades (one 24 tooth, one 18 tooth)
pair of tweezers
key caliper
6″ steel rule (spring wind)
½″ wood chisel
graphite air gun
can thin oil
can cup grease

Use of all of the above is self explanatory with the possible exception of the tweezers, key caliper, and graphite gun.

The **tweezers** are just an ordinary pair, such as you can get in any ten cent store for a few cents. They are used to handle small lock parts and especially in **setting up** pin tumbler lock cylinders. (See Section VII)

The **key caliper** is an instrument shaped as in Illustration No. 15 with which it is possible to measure accurately the depths of the cuts on keys of all types.

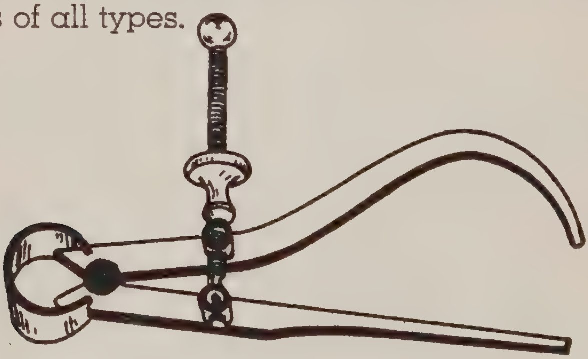


Illustration No. 15—A Key Caliper

It will be found especially helpful for duplicating bit keys by hand. The caliper can be set to the measurement of the old key, and the blank filed until the caliper just fits into the new cut.

The **graphite gun** is the locksmith's medicine kit for ailing locks. Powdered or flaked graphite is the only suitable lubricant for the tumbler

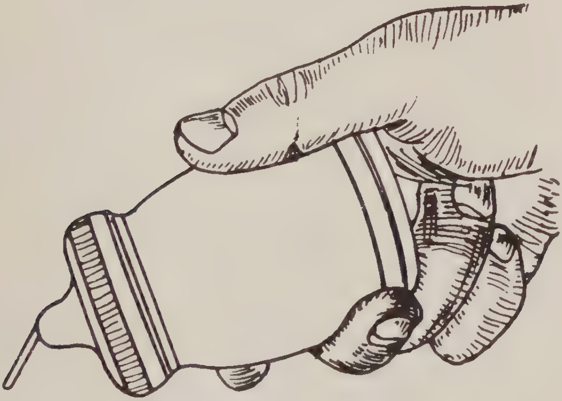


Illustration No. 16—A Graphite "Gun"

mechanism in all pin and disc tumbler locks. Oil or grease **gums them up** and attracts dust and grit, which soon interferes with proper operation.

Thin oil (Three-in-One or equivalent) is used, but **always very sparingly,** to coat the tumblers of lever locks, as a lubricant and as a precaution against rust. Little-used lever locks with tumblers of ferrous metals have been known to **freeze up** because the levers rusted together.

Cup grease is too thick to serve as a lubricant in any small desk, drawer, or cupboard locks. Its use is strictly limited to easing the boltwork on heavy exterior door locks, and mortise cylinder locks, etc., where there is no chance that any small parts will be mired down in the grease. Squeaking hinges should always have the hinge pins coated with cup grease, since oil runs on the floor and graphite is ineffective in such cases.

One of the world's best general-purpose lubricants is **graphite grease,** a mixture of good grade cup grease and powdered graphite. In most cases the locksmith can accomplish the same effect by spraying a light coating of graphite over a thin base of grease.

12. HOME-MADE BENCH TOOLS

Starting with the simple tools just mentioned, you can provide yourself with all the special tools required by utilizing ingenuity and whatever materials are available with which to work.

First of all, you will need a **thimble** and a **following tool** for working on pin tumbler cylinders. The **thimble** is nothing more than a device for holding the lock plug conveniently while it is being serviced. Illustration No. 17 shows a manufactured thimble, which can be duplicated in the shop by cutting a section of the bottom from a discarded cylinder, as in Illustration No. 18.

The **following tool** for standard cylinders is a short piece of half-inch round rod, notched at one end to receive the cam extension of mortise

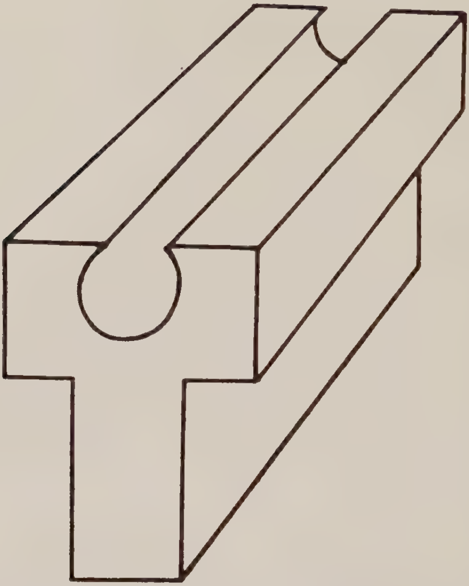


Illustration No. 17—Locksmith's Manufactured Thimble

cylinder plugs and left flush at the other end to form a tight fit against night latch plugs.

Since there are several sizes of cylinders, it will be necessary to provide a thimble and following tool for each. Those most often used will be for the small cabinet size cylinder (.40″ diameter plug) and the standard cylinder (.51″ diameter plug). In addition, Russwin standard cylinders, as well as a number of other makes, require a larger thimble for their thicker plugs. These can best be made from an old cylinder of the particular lock for which they are intended. The other size, little used by the beginner, is for the special Corbin master-keyed cylinder, considerably larger in diameter than any other cylinder in common use.

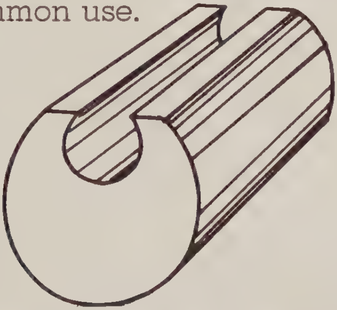


Illustration No. 18—"Home-Made" Thimble. Made by Filing the Bottom off an Old Cylinder

A broken key extractor for pin tumbler locks is another **necessity.** This usually consists of a short length of piano wire with a very small hook formed in the end. It is slipped into the keyhole alongside the broken key, and hooks over the point of the key. Other locksmiths prefer a piece of light fret saw blade mounted in a handle. This tool works the same way, but sometimes gets a better grip by hooking into the key all the way along its length.

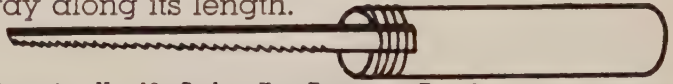


Illustration No. 19—Broken Key Extractor. Fret Saw Blade Mounted in Wood Handle

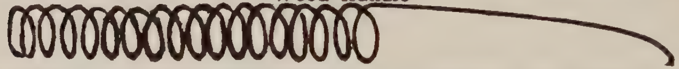


Illustration No. 20—Another Broken Key Extractor. Hook Made from Piano Wire with Handle Wound from Same Piece of Wire.

13. THE LAYING-OUT BOARD

In the course of ordinary lock repairing, it is sometimes necessary to completely dismantle a pin tumbler cylinder, removing both the tumblers and springs. Under such conditions, the need arises for a **laying-out board,** which is merely a device for keeping track of each pin segment as it comes out of the lock, in order that the parts may be quickly and accurately re-assembled in their proper positions. (See Illustration No. 21). It is particularly necessary to use such a board in servicing master-keyed locks, since the master key **will not operate the lock if even only one tiny tumbler be fitted in the wrong place.**

The board itself is made from a small flat piece of plywood, with eight parallel "V" shaped groves running across it to represent the eight tumbler positions of pin tumbler locks. Although five or six pin-tumblers are the common rule, the board should be able to accomodate an eight tumbler cylinder, since these are quite often encountered in hotels and office buildings.

At right angles to and across the grooves three lines are drawn, dividing each groove into four sections, one for the tumbler spring and one for each pin segment. Tumblers are distributed piece by piece to the board when they are removed from the lock, and have no opportunity to become mislaid or confused with other parts

As you develop your shop, you may want to provide yourself with additional items, including pass keys and pick keys to aid you in opening and fitting keys to handbags, suitcases and

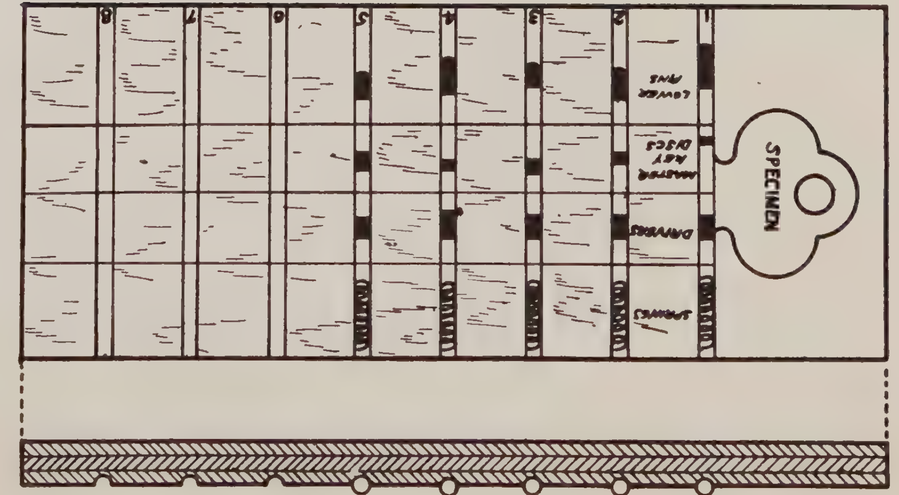


Illustration No. 21—A Laying-Out Board Made of 3-Ply Veneer. Tumblers from a 5-Pin Master-Keyed Cylinder in Place trunks, etc. These items all depend entirely on what type of work you are called upon to do, and can best be fashioned by you, yourself, after your experience enables you to know what you need.

14. THE LOCKSMITH'S KIT OR CALL BOX

If you contemplate any outside calls, you will need to equip yourself with a compact but complete kit of service tools. You can never know what to expect, so you should **be prepared for any minor repair job.** All the smaller bench tools including files, hammers, special lock tools, drills, screw-drivers, etc., should be included, besides a chisel, brace and bit, plane, and similar carpenter's tools if you have undertaken to install new locks as well as repair old ones.

Since size and weight are a factor in determining what can be included in such a kit, every tool selected should be chosen for its **adaptability to various uses.** For instance, a large steel-shank screw driver can also be used as a crow bar in resetting sagging doors, etc.

My own service kit, weighing about thirty pounds, contains the following items. Although I make calls in a light truck now, the kit remains almost exactly the same as when I carried it on streetcars and busses.

TOOLS

small screwdriver
medium screwdriver
large screwdriver
½" wood chisel
6" sheet metal snips
16 oz. carpenter's finishing hammer
6 oz. cross pein machinist's hammer
6" side cutting pliers
8" end cutting nippers
12" hack saw (dismounted)
keyhole hacksaw
countersink drill for metal
hand drill with complete set carbon drill points
assortment small taps and dies
tap wrench and die holder

graphite gun
assortment of ten files, including flat, round, square, and triangular in a variety of sizes
focusing flashlight, with extra globe and batteries
6″ steel rule
following tools and thimbles for servicing lock cylinders
expansion bit, ¾″ to 1½″
$\frac{9}{16}$″ wood bit (for mortising locks)
center punch
thread gauge
magnet and string
plumbob
broken screw extractor (easy out)
small soldering iron
pin or hand vise
6″ Crescent wrench
special spanner wrenches as provided for certain locks by manufacturers

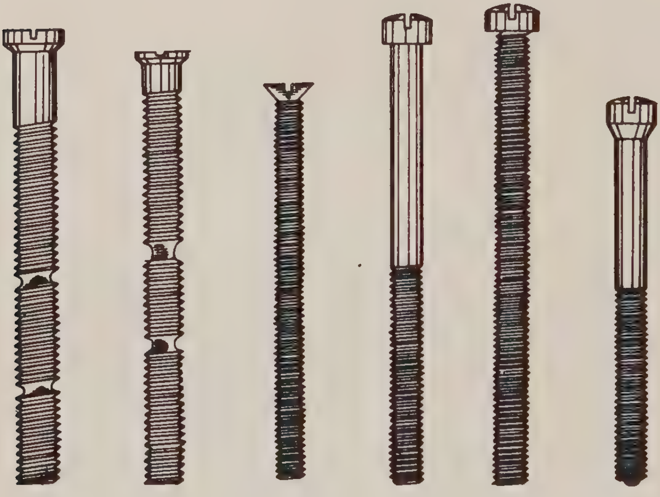


Illustration No. 22—Typical Repair Parts

OTHER ITEMS

tincture of iodine
small roll sterile gauze
roll electrician's friction tape
tube liquid glue
solder and solder acid in crack-proof bottle
extra springs of all types
box assorted lock tumblers
assorted wood screws

assorted small machine screws
few common nails
hasp and padlock (for sale)
pass keys and small assortment key blanks
broken key extractors
new lock spindles
spindle washers
spindle set screws
cylinder set screws
cylinder lock turnpieces, or cams
matches

15. IDENTIFICATION OF TOOLS

Most mechanics like to be able to recognize their own tools at a glance. Some paint distinctive stripes or rings on every tool in special color combinations.

Another way is to etch your name in acid into the metal in each tool. Regardless of the relative merits of these or other systems, some method should be adopted so that any tool can be quickly and positively identified.

Illustration No. 23—More Typical Repair Parts: Spring, Screws, Washer

The service kit should bear your name and residence address in a conspicuous place, perhaps notice of a reward for its return, but in any event **nothing should be said to call the finder's attention to the fact that a locksmith owns the box.** Such a statement might tend to affect his decision to return the tools. Also, a dishonest person might be tempted to try to use them for personal benefit.

Any loss or theft of locksmith's tools that might prove of value to criminals should immediately be reported to police authorities not only as a precaution against their use in burglaries, but as a defense for the honest locksmith if the thieves subsequently leave his tools at the scene of a crime.

16. STOCK OF KEY BLANKS, REPAIR PARTS, ETC.

Besides tools, every shop must be equipped with simple repair parts for the locks that are to be worked on as well as an assortment of key blanks.

The repair parts should consist of a variety of springs, knob screws, extra pin tumbler segments, case and cover screws, and extra lock spindles.

Illustration No. 24—More Typical Repair Parts

The total number of different key blanks used by the various lock manufacturers is so great that some of the locksmith supply houses use a 300 page catalog to illustrate them. Of the ten or twelve thousand different **keyway sections,** however, there are a number of so-called standard cylinder keys that are used on most stock locks. The following list should prove helpful in selecting a few of the fastest moving blanks for stock purposes.

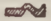
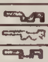
In referring to key blank catalogs, be sure to note whether the cross sectional views are of the end of the key or of the keyhole. Many keys have reverse sections and **confusion can result** from misinterpretation of the cross-sectional diagram.

17. THE LOCKSMITH AS A MERCHANT

Many locksmiths derive no small part of their incomes from the sale and installation of new locks. Since most jobbers and wholesalers allow the same discounts to an established locksmith that they ordinarily give small hardware dealers, a business-minded locksmith is in a position to meet competition.

Often a customer approaches a locksmith with a request for advice on some particular

CHART OF A FEW OF THE MOST COMMONLY USED KEY BLANKS

Manufacturer	Manfacturer's Blank Number	Independent Lock Company Number	Keil Number	Cross Section of Keyhole (Top of keyhole at left)
Barrows	615B	1021B	126E	
Best	1A1A1	1114A	154P	
Briggs and Stratton	75101	1098M	154SS	
	82114	01098LA	153PR	
Corbin	8618	1000G	66A	
	97	1001	65	
	27	1001EB	64	
	99	1000	60D	
	67	1001EN		
Eagle	5014	1013	160B	
Hurd		1125C		
Keil	2K	1079	2K	
	2KK	1079B	2KK	
Lockwood	308B	1004	122	
Master	1K	1092	155S	
	7	1092B	155X	
Norwalk	84	1017	126	
	86	1017B	126B	
Penn	510B	1016	119	
	520B	1016N	118B	
Reading Knob Wks.		1119	84AA	
Reading Hdwe. Co.	B632	1019		
Russwin	852B	1011	84	
	981	1011P		
Sager	1804¼	1047A	137A	
Sargent	F258BF	1010B	101	
	265 BU	1010	A102	
	265 BR	1009	103	
Schlage	923C	1145		
		01054		
	920A	1307A		
Yale	13½	997D	12C	
	8	999	2B	
	9278A	01122A	6S	

locking problem. The craftsman who **knows his business** and has at hand samples or catalogs to show what he deems necessary is well on the way to being employed to furnish and install the recommended locks.

As an example, let us take the case of an eating house proprietor who a year or two ago approached a locksmith with the complaint that his pinball machines were being hijacked at night almost continually, and that no lock he was able to buy seemed to keep the thieves from entering his establishment and hauling away whatever they wanted. The locksmith made an inspection of the premises, suggested that the customer allow him to burglar-proof his building, and was immediately employed to do so. With the help of a blacksmith he prepared night-bars on all the doors but one, and installed an interlocking rimlock on the other door which locked the door right to the frame. The restaurant owner had no more trouble, the locksmith received a tidy fee, and the successful resistance of his night-bars to several attacks led to similar installations in a number of warehouses and garages in the industrial district.

Most lock shops carry in stock a number of padlocks of various grades to offer to customers who come in with a fifty cent lock to have keys fitted to. Almost anybody will appreciate being offered a new lock with two keys of the same or superior quality at the same or less cost than fitting up the old one with keys.

Nightlatches, keyhole locks, pass keys, lock spindles, and cupboard locks are a few of the other items many locksmiths carry. Find out what your customers want and **have it ready for them.** It pays not only in profits but in customer satisfaction and advertising value.

SECTION IV

WARDED LOCKS

Of all locks in general use today the simplest and least secure (from a standpoint of interior construction) is the warded lock.

18. CONSTRUCTION

A ward is merely an obstruction of some type which prohibits the key from operating unless a corresponding notch or ward cut is made in the key. There are a number of different types of wards and many ways they may be applied in the lock.

The most noteworthy weakness in the construction of a warded lock is the fact that a pass key can usually be made out of one key that will fit any lock in the series, although there may be from four to twenty or even fifty so called "changes" in the set.

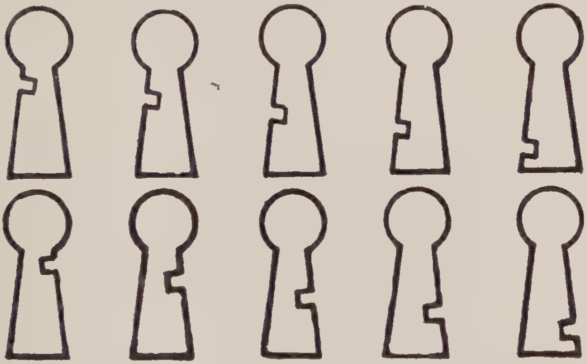


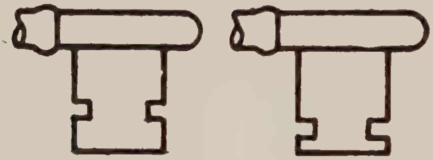
Illustration No. 25—Keyhole or Case Wards

In Illustration No. 25, each little notch in the key bit is a case or cover ward. There is an obstruction sticking out into the keyhole on the lock case that refuses entry to any key except one having a longitudinal slot cut in it in the same location as the ward on the lock case.

But if we file away the wedge shaped bit, and make a key shaped as in Illustration No. 26, we have a key blank that will fit into any of the various keyholes.

Naturally this would not be done if a key was being fitted to a single lock, for it would remove a large measure of the limited security of the lock.

END WARDS.



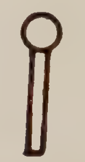


Illustration No. 26—End View of a Thin Bit Key Blank

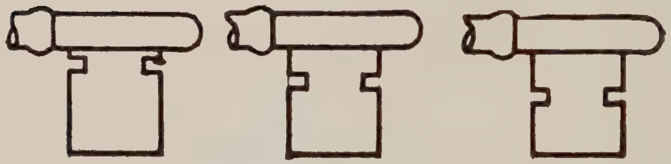


Illustration No. 27—End Wards

The notches in the keys in Illustration No. 27 are known as end wards. These obstructions are also attached to the case, but at the end of the key. Illustration No. 28 shows how these wards may be placed in the lock. Assuming that the boltwork rides on the bottom of the key, as it usually does in this grade of lock, a key must only be filed on both ends of the bit at the point it meets the ward to open this lock. But here again, if we cut the key down at all five different end ward locations, and use a blank as in Illustration No. 29 we have a pass key to open every one of the fifty locks in the series. (10 case ward locations multiplied by 5 end ward locations gives a total of 50 possible key changes.)

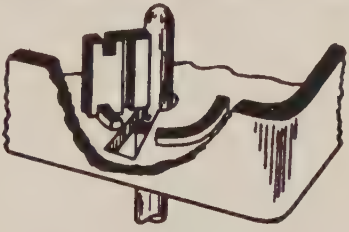


Illustration No. 28—End Wards

Therein lies the weakness of the warded lock. The key needs only to be cut away past all the wards and it will open any similar lock. For this reason warded locks are seldom placed in service where any great amount of security is required. They serve quite satisfactorily to keep the family cedar chest, sewing machine, piano, or even the jam closet locked against meddling children, but beyond that **their utility almost ceases.** Since a warded lock is in itself little protection against illegal or forcible entry, wards are most often used in conjunction with some other type of security, usually the lever tumbler plan.

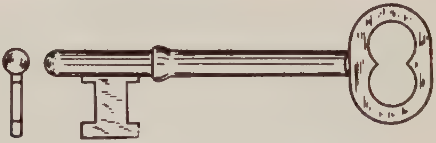


Illustration No. 29—A Typical Pass Key for Warded Bit Key Locks

Perhaps the most commonly used straight warded lock today is the inexpensive padlock. This is usually designed with a flat or slightly corrugated steel key, to be sold for between ten

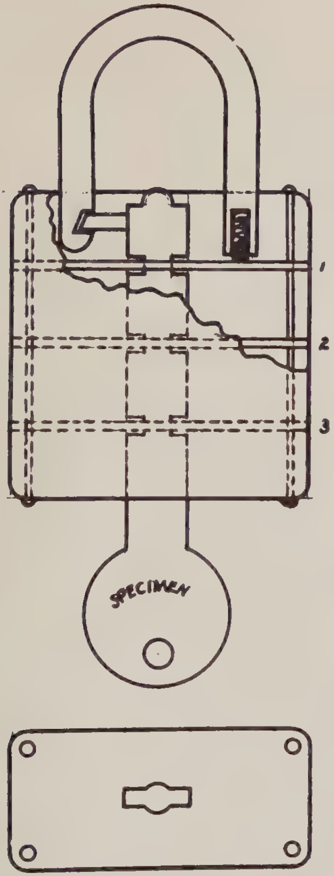


Illustration No. 30—A Typical Warded Padlock

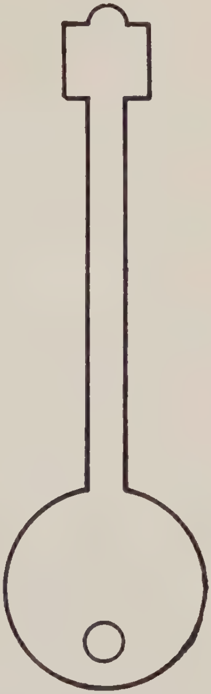


Illustration No. 31—Pass Key to Warded Padlock in Illustration No. 30 and twenty-five cents. Inside the lock are arranged a number of flat steel plates.

These plates, spaced at various intervals, provide a number of wards that restrict the key in its turning motion unless notches are filed on each side of the key everywhere there is a plate. But here, again, enters the weakness of the warded lock. No matter how many ward plates are placed in the padlock, a key filed away as in Illustration No. 31 **would operate all of the locks** in a given set.

19. FITTING KEYS TO WARDED LOCKS

Because of their simplicity of construction, fitting keys to warded mortise locks is a relatively easy operation. Indeed, in many cases it can be done without removing the lock from the door.

With the aid of a flashlight the shape of the keyhole can be examined, and a blank selected as near as possible to the exact size. An **oversized,** rather than an **undersized** blank should be selected if the exact size required is not readily available. A large blank dressed down to the right size will fit snugly and never give trouble in riding too high or too low in the keyhole. Blanks that fit too loosely are apt to cause trouble.

The initial cut of course is the case ward cut if there is one. This should be carefully plotted on the key in its exact place before filing. The actual cut should be no larger than is necessary for easy entrance of the key.

Once the key has entered the lock, the end wards can be located by smoking up the bit in a match or candle flame. When pressure is applied in a gentle attempt to turn the key in the lock, **the wards will rub off the blacking on the key.** Then, when the key is filed where the bright spots appear in the blacking, the ward cuts have been made. Adjustments are then made if they are necessary to make operation faultless, and the key is ready for service.

For fitting keys to warded padlocks, the steps are even simpler, since there are no case wards. The simple side wards can all be located by the impression method described above. All that is necessary to start with is a blank of the **proper shape.**

20. REPAIRING WARDED LOCKS

Because of their comparatively flimsy construction and low cost, it is usually not practical to repair warded locks. Cases will develop however, in which a locksmith will find it necessary to make repairs to a lock of this type for any of several good reasons. While it is ordinarily better to recommend to a customer that he buy a new lock, it is not always possible to get one to fit the mortise or one that will satisfy the customer who thinks he really has a lock of great security. This is especially true in regard to imported chests, desks, strong boxes, etc., where replacements are not available in this country.

In any case, a careful inspection of the individual lock will show the cause of the trouble. **The main thing to look for is a broken spring.** It may not appear broken when you inspect it, but look at the end away from where it is connected to the boltwork. Sometimes a spring will crystallize here from constant usage. Even a small piece breaking off may jamb the lock if it falls into the moving parts.

On certain lever type locks wards are used to aid in producing a larger number of possible key changes, as may be necessary in hotels, dormitories, etc. Often these wards break off or are removed by wear and must be replaced in order to keep other tenants' keys from operating the locks. Quite often wards can be replaced or even new ones created by boring a small hole and forcing a short length of a brass escutcheon pin into the lock case where the ward is desired. This method can of course be used only when the case is of cast or very heavy sheet metal. On thin metal cases wards are generally only indentations punched into the metal with some small sharp instrument.

SECTION V

LEVER TUMBLER LOCKS

The lever tumbler mechanism was undoubtedly the **first satisfactory arrangement** for providing security in early-day locks. In modern manufacturing practice, lever tumbler action is used in a great variety of locks for hundreds of different purposes. From the relatively small two-lever drawer lock to the husky sixteen-lever double custody safe deposit box lock, there is a lever lock for almost every need.

The lever tumbler principle, when applied to a lock of good quality, carries a degree of security meeting or surpassing any ordinary requirements for general locking purposes. Locks of this type can in most cases be master-keyed, keyed alike, or all keyed differently.

21. THE LEVER TUMBLER PRINCIPLE

The lever tumbler mechanism itself is relatively simple compared to some of the more complex arrangements.

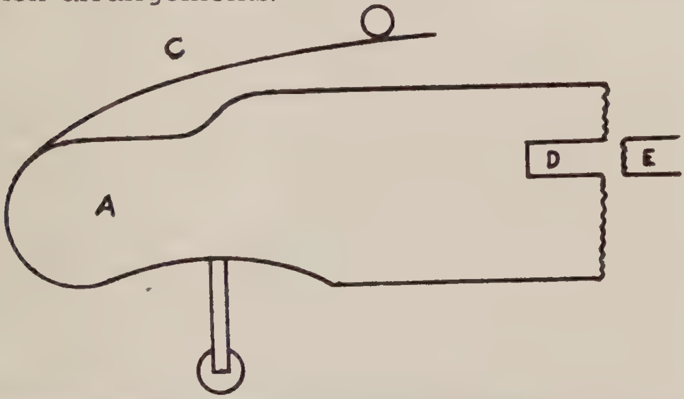


Illustration No. 32—A Lever Tumbler with Key Inserted to Bring Gate Opposite the Post on Bolt

Each flat plate, or lever, hinges at a fixed point (A) and is held down against a stop by pressure of a flat spring (C). Each lever has a **gate** (D) filed in it, but these gates are all located at different places. When the proper key is inserted and turned, notches of various depths raise all the levers whatever distance is required to line all the gates up exactly opposite the **post** on the bolt (E). Then, when the key is turned a little farther, a corner of the key catches the bolt and slides it back. Since there is no resistance to the **post** entering the **gate,** the lock is opened. But if the key is not the right one for the lock, and even one gate doesn't line up to let the post slide into it, the lock cannot be opened.

This particular illustration was drawn from a safe deposit lock lever. The notches in the lever near the gate get caught in the notches in the post unless the key is a perfect fit. **This adds greatly to the security.**

Other locks have different types of levers, but the principle is always the same. Notice the difference, however, in the lever in Illustration No. 33. This is a lever from a lock in which the bolt has to be held in an unlocked position when it is open. Here the action of the key merely allows the post on the bolt to slide from one side of the lever to the other. Whether locked or unlocked, however, the post is always snug in one of the two positions. When the key is out of the lock, the bolt can't move. This feature is necessary on all locks where it is desired to remove the key in the unlocked position. Otherwise vibration or slamming a door might jar the bolt half-way out, and in that position the key would **neither lock nor unlock it.**

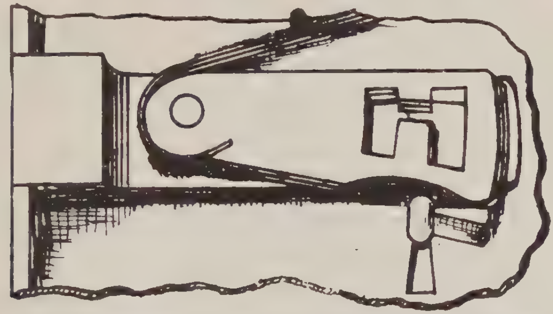


Illustration No. 33—Bit Key Levers with Lock Bolt in Unlocked Position

In the case of the safety deposit box lock, and of certain mail box locks, it is intended that the user shall not remove his key until he has safely locked up the box again. As a safety feature, then, manufacturers have made it **impossible to leave these boxes unlocked.** The key cannot be removed until the bolt slides out to the locked position.

Until a few years ago levers were sometimes so arranged that they pivoted on two different points instead of all on the same pin. When this is the case, the key fits in between the levers and separates them to the proper degree to open the locks. Notice the difference in the keys. (See Illustration No. 34)

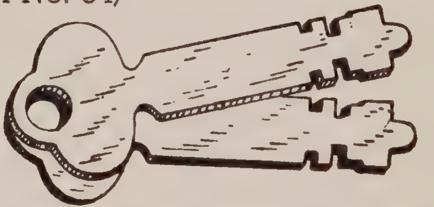


Illustration No. 34—Double-Bitted Cabinet Lock Keys

There was a slight advantage to the user in the double bitted type. The key did not have to be inserted in the keyhole in a certain position. Either right side up or wrong side up, it still operated, and each side of the key got only half the wear, theoretically.

But the disadvantages were many. Keys were very difficult to fit and hard enough to duplicate. Levers were easily mixed up when the lock was disassembled.

Present day standardization of manufacturing practices has all but eliminated this type of lock except for interior doors on safes where bulk is an asset rather than a hindrance.

22. FITTING KEYS TO LEVER LOCKS

Key fitting to lever locks is in many cases greatly simplified by a small window in the lock case just over where the post on the bolt meets the gates on the levers. It is only necessary to remove the lock from the door, select or prepare a suitable blank, and notch it to fit by watching the action of the blank through the little window.

Since lever locks contain a great many loose parts and are often hard to re-assemble,

they should ordinarily not be opened for key-fitting, but only for repairs.

By smoking up the blank the lever locations can be easily spotted, as described for warded locks in the previous Section.

Get the lock in the locked position, with the bolt extended. Start with the lever closest to the window, and carefully, a little at a time, file down the blank at lever position number one until the bolt post is exactly opposite the gate. Then follow the same routine for the second lever, and the next, until the gates on all the levers form a straight line. Try turning the key **gently.** If it binds, look for the cause. You'll probably find that each lever has to be a fraction deeper. If it turns over but seems to stick, re-smoke the key and unlock it again. The place it binds hardest will show as the shiniest spot. A gentle touch of the file should correct the trouble.

In filing keys, be very careful to get the notch for each lever **directly under that lever.** Don't make it any wider than is absolutely necessary, and always use a file thinner than the lever which is to fit into the notch. Otherwise there may be a danger of having more than one lever fit into one notch. All kinds of grief can result. Duplicate keys for lever locks should always be cut on a key machine, not by hand. Some levers are so thin that the slightest error in width of a cut may let an extra lever into the hole, causing the lock to fail to operate, perhaps not immediately, but sometime in the future.

A key for a lever lock should be of steel for best results; in any case **never fashion a key from a metal softer than that in the levers.**. Since most levers are made of brass or bronze, any harder metal will do. But avoid soft blanks. They break easily, wear quickly, and may provide real trouble.

23. REPAIRING LEVER-TUMBLER LOCKS

Since lever-tumbler locks are in such general use throughout the country, their repair is an art that every locksmith quickly learns.

The main cause of trouble is **broken or disconnected lever springs.** Whether the steel actually breaks or falls out of its slot, the lock is almost certain to be jammed. Lever lock springs are ordinarily made of fine flat spring steel, slightly narrower than the thickness of the lever to which it is attached.

When installing new springs, be sure to remove from the lock case all the broken pieces of the old one, and get the levers back in exactly the same position they were in or the key will not work. In this connection, **pay no attention** to the numbers on the levers. Ordinarily they do not tell the position of the levers in the lock, but merely indicate the relative depth of a cut in the key. In a five lever lock, you might find levers stamped, in the order of their removal, 1, 2, 1, 5, 3. Those numbers would indicate a shallow cut, a deeper cut, another shallow one, a very deep one, and a medium depth cut.

The only **sure** way to keep the levers in proper position is to take them out one at a time, pile them on the bench in a line from left to right and reverse the routine for replacing them.

Spring stock for replacements should not be heavier than the original, lest it cause unnecessary wear on the key. Do not try to use the old spring if only the end is broken off. If it is crystallized in one place, it will soon break at a new point.

The spring itself should be cut to length and bent to approximate shape before being set into the spring slot. A spring should fit snugly into this slot, and be held in by slightly rolling the metal on both sides of the lever up over the sides of the spring. This is best done with a cross-pein hammer. **Do not make the lever bulge, however, or it will bind against other levers.**

Another source of trouble is worn or chewed up levers. Sometimes a steel key in use for a long time will gradually remove enough metal from the bearing surface of a lever to interfere with operation of the lock. When this happens, it is best **not** to widen the lever gate with a file, as is commonly done, because that destroys a great measure of the lock's security. The best remedy is probably to clean up the rough spot with a fine file, and then pound the lever a little thinner at the bearing surface, which usually will flatten it enough to widen the lever where required.

Sometimes the post on which the levers are pivoted comes loose. This is easily fixed with a light hammer, by riveting the fixed end into the case solidly.

Occasionally there may be a broken part that will require mending. Always remember that **solder is not suitable material for repair work if there is to be any direct strain or scraping against it.** The metal is just too soft to be practical. It is best in such cases to resort to brazing with brass. The cost, if you don't have your own equipment, should not be high if you tell the welder before he does the job that you will dress off the extra metal yourself.

Probably the commonest complaint of the

lever lock is the bent bolt. Where a lock has been jimmied, pried open, or pushed against when locked, it is usually only necessary to take it apart and straighten the bent parts. Since bolts are usually made of brass or bronze, they bend readily and are easily straightened. The only caution is to do it **carefully and slowly,** warming the metal slightly in cold weather to prevent its crystallizing and breaking.

Lever type mortise locks, when they have been attacked by burglars, usually come to the shop with a cracked or broken case, especially if that part is of cast iron. While a new case is sometimes preferable, it may be necessary to have them welded if the break is not too bad. When this is done, **all the small parts must be removed from the lock,** since intense heat will take the temper out of springs and soften brass castings. The actual welding should, where possible, be done on the outside of the case to avoid the necessity of dressing off excess metal.

In many cases trouble with lever locks is directly traceable to poorly fitted or wornout keys. In some instances a new key cut a little shallower on a slightly heavier blank will remedy the ill. The possibility should always be explored **before** spending shop time looking for other trouble.

SECTION VI

DISC TUMBLER AND WAFER LOCKS

One of the many accomplishments of the lock industry in recent years has been the development of the inexpensive **disc tumbler lock.**

Ranking somewhere below the pin tumbler and better grade lever lock in security, the disc tumbler principle has been applied to a wide variety of locking problems. Many automobiles, as well as slot machines, pin ball boards, and vending machines have been equipped with disc tumbler locks. Popular because of their low cost, these locks have found their way even to the inexpensive grades of builders hardware for residential construction.

24. THE DISC TUMBLER MECHANISM

The disc tumbler principle, while essentially similar to the pin tumbler idea in operation is **very different** in construction features. Disc tumblers are shaped as shown in Illustration No. 35, and are stamped or cut out of thin sheet metal. They are placed in slots in a core (See Illustration No. 36) with the hooks alternating from side to side and a small coil spring under the hook of each tumbler to exert a constant upward force. The key looks almost exactly like one for a pin tumbler lock, except for its smaller size. When the key is inserted, it goes **through** the punched-out hole in each tumbler, setting the discs flush at each side of the core, and permitting it to rotate in the shell.

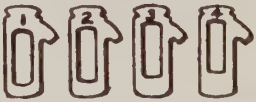


Illustration No. 35—Disc Tumblers

25. CONSTRUCTION AND SECURITY OF THE DISC TUMBLER LOCK

Most disc tumbler lock cylinders are made as die castings, or cast from an alloy inferior to brass for the purpose. For this reason **they are hard to repair.** The usual five tumblers do not give as many key changes as a pin tumbler lock with the same number of tumblers, because there are only four or five variations in each tumbler. Security, then, is limited to a theoretical 1024 possible changes (4^5 or 4 to the fifth power) but in actual manufacturing practice this is further reduced to about 500 or even 250. Disregarding the loss of security from a looser fitting plug, the disc tumbler lock has only about 1/200 or even 1/400 the security of a pin tumbler lock of similar size and shape.

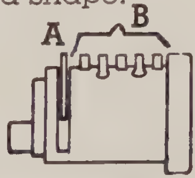


Illustration No. 36—A Disc Tumbler Cylinder Without Key Inserted: (A) Retainer Spring Ring. (B) Tumblers

Instead of being fastened in the cylinder **shell** by a **cam** or **tailpiece,** the disc tumbler plug is usually secured by a spring clip or **retainer spring** near the back of the plug. (See Illustration No. 36) When the key is inserted, a small wire can be introduced through a hole in the shell to depress this retainer and the core can be removed.

26. REPAIRING DISC TUMBLER LOCKS

Repairs to disc tumbler locks consist **almost entirely** of replacing defective springs or tumblers. Manufacturers have made new replacement cylinders for these locks available at such low cost that no locksmith, even a beginner, can afford to spend shop time attempting repairs. In most cases it is more costly for a customer to have two keys fitted to a disc tumbler padlock, for instance, than it would cost to replace the lock, including new keys.

In this connection refer to Section III, for a discussion of carrying new locks in stock to sell to customers under these circumstances.

Some manufacturers at one time adopted what is known as a **crushable** disc tumbler for repairing locks of this type. These crushable tumblers were especially popular a few years ago when almost all automobiles were equipped with disc tumbler door, ignition, and tire locks. The tumbler was really an **adjustable** one, which was the same size for all cuts in the key. After the key was inserted, the tumblers were crushed into shape. While the idea of carrying only one simple size of tumbler was very convenient, the crushable tumbler was unpopular because it was impractical. In most cases the tumblers crushed unevenly, causing binding or sticking, and in nearly all instances crushable tumblers left sharp corners sticking out to wear the soft metal of the lock shell, which when ground away in that manner formed a metallic dust which interfered with proper action of the lock.

At its best, the disc tumbler lock is a poor substitute for a pin tumbler mechanism, and to further reduce its security and effectiveness by filling it with mashed-up tumblers was considered poor practice.

TREND OF THE DISC TUMBLER LOCK TODAY

Around 1930 disc tumbler locks were all the rage for autos, vending machines, pin ball boards, and even padlocks. There has been a gradual trend away from the disc tumbler mechanism, however, since experience proved that they were not strong enough to resist jimmying or secure enough to prevent unauthorized entry with keys that were not intended to fit them. One company today manufactures a genuine pin tumbler padlock with a laminated steel case that sells for less than a competitive die cast disc tumbler padlock. Common sense dictates that the pin tumbler lock will continue to gain favor under such circumstances.

27. THE SCHLAGE WAFER TUMBLER LOCK

The greatest improvement to the disc tumbler principle in recent years has been the introduction to the market of a **wafer tumbler** cylinder lock by the Schlage Lock Company of San Francisco.

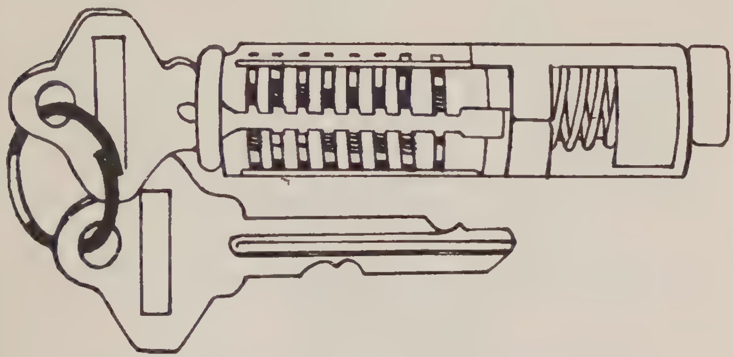


Illustration No. 37—Wafer Tumbler Cylinder Lock

In this lock the die cast cylinder has been discarded in favor of a tubular steel plug revolving in a steel shell which is built inside the knob of the Schlage unit-type lock. The **wafers** or tumblers of this lock are made of considerably heavier metal than the discs in previously mentioned types. As an added security feature, the number of tumblers has been increased to eight, with provision being made for almost 1000 absolutely different key changes. The interior construction of this "A" type Schlage lock is such that the key to one can seldom be made to operate another.

Inasmuch as these relatively inexpensive locks are proving very popular on modest residences, motor courts, tourist cabins, beach homes, etc., a few simple service instructions cannot be out of place. (For directions for removing these locks from doors and installing same, see Section IX.)

The **core** of this lock (Illustration No. 37) uses 3 different types of wafer tumblers. Type A, having a restricted opening, is used only on the eighth or last tumbler position on the tip of the key, which is cut either on the right or left in all cases, never left blank.

Wafers B and C are used in the other seven tumbler positions on ordinary stock locks, and on special jobs where a masterkey controls the whole set.

Note that besides the end, or eighth cut, no Schlage key of this type (except a master key) is ever cut on more than three of the remaining seven tumbler positions. (See Illustration No. 37) These cuts can all be on one side of the key, or they can be alternated in any conceivable manner, **but there should never be more than a total of four cuts if security is to be maintained.**

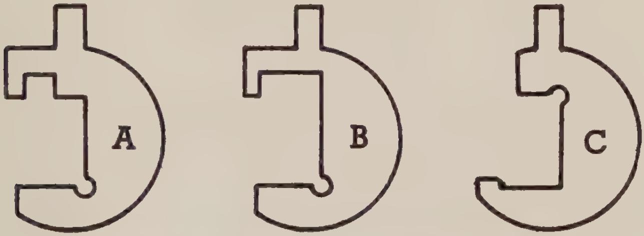


Illustration No. 38—Schlage Wafer Tumblers

SECTION VII

PIN TUMBLER LOCKS

Locks embodying the pin tumbler principle are not only the most widely used and universally accepted throughout the world, but are also generally recognized by expert and layman alike as the **highest type security available.**

The greatest advantage of the pin tumbler mechanism aside from its burglar resistance, is its adaptability to any type of locking problem. Pin tumbler locks are available for almost any imaginable use. You find them everywhere: on dog collars, money chests, public buildings, residences, automobiles, and even bicycles.

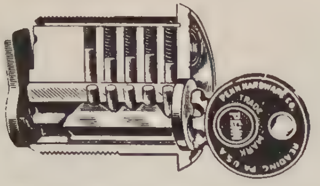


Illustration No. 39—Cut-Away Section of a Pin Tumbler Cylinder

28. THE PIN TUMBLER MECHANISM

The pin tumbler lock, unlike any of the other types, depends for its security on a number of round **pins** or **tumblers** operating in a cylinder not necessarily a permanent part of the lock itself. The ordinary mortise door lock of this type, for instance, is used with a cylinder like that in Illustration No. 39. The cylinder, although an integral part of the lock, is an individual unit and is readily removed for repair or service **without disturbing the lock itself.** This feature is a particular advantage in large buildings and other institutions requiring frequent changes of combinations when tenants move, authority is changed or access restricted.

Operation of the pin tumblers should be quite clear after studying the illustrations. Each

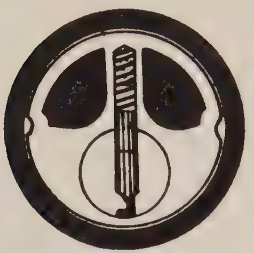


Illustration No. 40—Cross Section of Cylinder-Pin Tumbler at Bottom

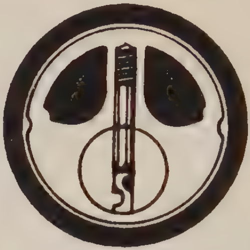


Illustration No. 41—Cross Section of Cylinder-Pin Tumbler Raised by Key to Correct Position

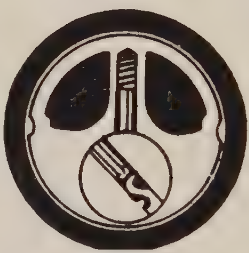


Illustration No. 42—Cross Section of Cylinder Plug Partly Rotated, Carrying Pin Tumbler With It

tumbler or pin is divided, in the ordinary cylinder, into two parts. The upper part, flat on both ends, is known as the **driver,** and the bottom part, or **pin,** is either rounded or slightly pointed on the lower end to fit the "V" shaped grooves or **cuts** in the key. A separate coil spring above each tumbler constantly forces it downward. When the proper key is inserted, the various depths of the cuts in the key compensate for the different length of the pins, and the dividing point between each two pin segments is brought into line with the top of the **core,** allowing it to rotate in the **shell.** When the core turns, it carries with it the **cam,** which is the thing that actuates the boltwork of the lock. That, essentially, is the complex story of the pin tumbler lock.

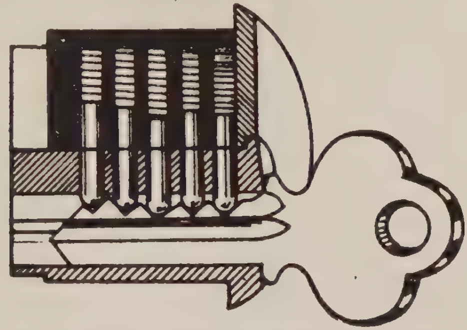


Illustration No. 43—Pin Tumbler Cylinder with Correct Key Inserted

29. SECURITY OF THE PIN TUMBLER MECHANISM

Locks of the pin tumbler type do not depend for security on the tumblers alone. Each manufacturer has a number of different **keyways,** or keyhole shapes. These, combined with an almost countless number of tumbler variations, provide a great reservoir of key changes.

Most standard sized pin tumbler cylinders have five tumblers, although as few as three and as many as eight are in general use. Assuming that there are ten different lengths each pin can be (most locks have at least that many), and five tumblers, then there would be 100,000 (10^5 or ten to the 5th power) **different** theoretical key changes. But twenty or so leading manufacturers each have from five to a dozen or twenty different keyways, so our 100,000 becomes 2,000,000 and then 20,000,000 if we agree that each maker uses an average of ten keyways.

The possibilities for security, then, are great. **There is roughly one chance in 20,000,000 of anyone else having a key to fit a given pin tumbler lock.**

Lock manufacturers have shaped the keyways of their lock cylinders as scientifically as

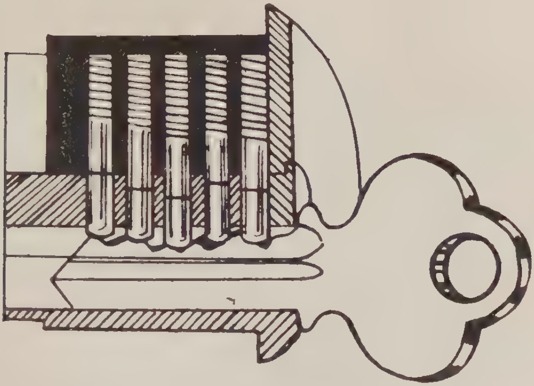


Illustration No. 44—Pin Tumbler Cylinder with Wrong Key Inserted

possible. Milled or corrugated keyways offer maximum resistance to unauthorized entry. Generally speaking, the smaller the keyhole and the more obstructions in the keyhole there are, the harder it is for even an expert to open the lock. The keyholes should not be made too small, however, or the soft metal keys would be continually breaking off in the lock.

30. REMOVING PIN TUMBLER LOCK CYLINDERS

Nationwide standardization of cylinder dimensions and thread sizes has greatly aided the locksmith as well as the general public. In many cases, where it is necessary to remove a cylinder for key changing or repair, a substitute or loan cylinder can be easily fitted to the lock while the regular cylinder is in the shop.

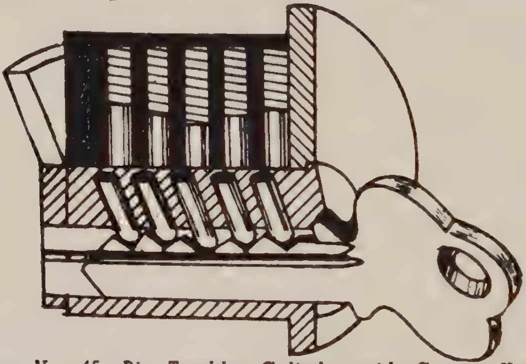


Illustration No. 45—Pin Tumbler Cylinder with Correct Key Inserted, Showing Operation of Cam which Actuates the Lock Bolt

Standard mortise cylinders, or cylinders for locks mortised into the door, whether there is a single cylinder or one on each side of the door, are removed from the lock by loosening a cylinder set screw (See Illustration No. 46) in the edge of the door. In some locks this screw is concealed by a **false front** or **armored front,** which must be removed before the set screw is available. After this screw is loosened, the cylinder is easily unscrewed from the lock case.

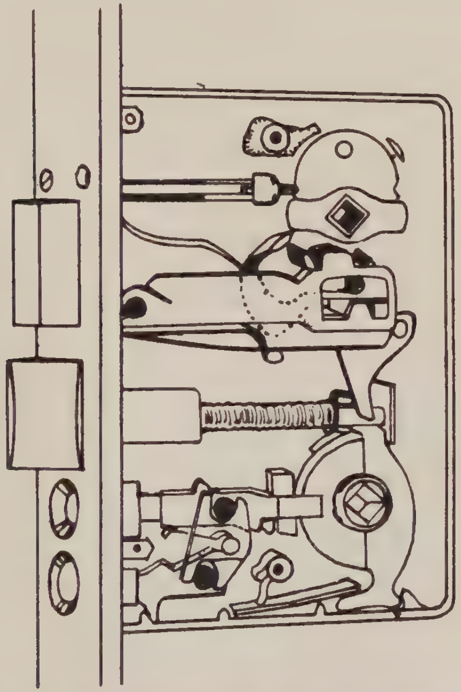


Illustration No. 46—Cylinder Front Door Lock Showing Interior Construction

Nightlatch or rim lock cylinders are held in place by **connecting screws** through a **back plate.** The lock case itself usually has to be removed before these are accessible.

Cylinders on drawer and cupboard locks, automobile latches, padlocks, and many other types are not removable in this way and are generally contained in the lock itself. In such

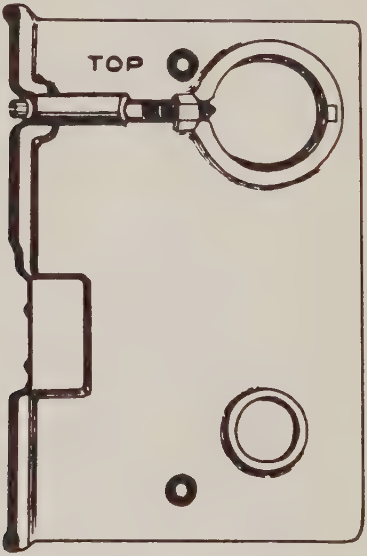


Illustration No. 47—Lock Cap with Set Screw for Fastening Cylinder cases, the cylinder is available for key changing or repair only after the lock is almost completely disassembled.

31. FITTING KEYS TO PIN TUMBLER CYLINDERS

Naturally the most common reason for opening a pin tumbler cylinder is to fit keys. The customer may request keys fitted to the lock as it is, or he may wish the combination changed first and new keys fitted. In either case the plug must first be removed from the cylinder. First take off the **cam** or **tail piece,** whichever the case may be. Then, if the old key is available, the plug can be slid out of the lock, being closely followed by a **follower** or **following tool** to keep the springs and drivers in the **shell** from spilling. The **following tool** is a piece of round metal the

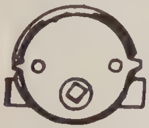


Illustration No. 48—View of Turn Knob Disc Complete in One Unit

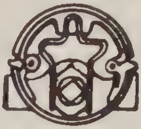


Illustration No. 49—View of Turn Knob Disc Showing Internal Construction same size as the **plug,** and notched at the end to fit closely against it. It is left in the lock while the **plug** is worked on, and leads the plug back when the lock is assembled.

Once the plug is out of the lock, it is put into a **setting up tool** or **thimble,** which is merely a rack that fits in the vise to hold the plug firmly without injuring it. (See Illustration No. 17)

Assuming that the project is to change the combination, we first **dump out all the old pins from the plug.** Then a new key is selected or prepared, differing enough from the old one to be seen at a glance. This is placed in the plug and new pins inserted to fill the tumbler holes. All these must be at least long enough to come

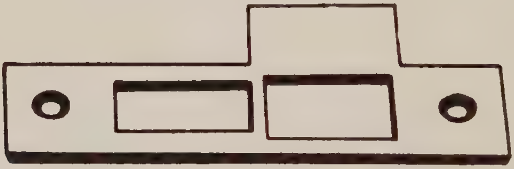


Illustration No. 50—Lock Strike

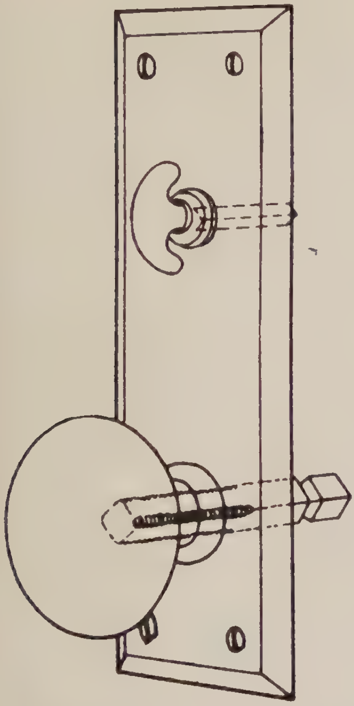


Illustration No. 51—Escutcheon, Knob and Turn Knob for Inside of Cylinder Front Door Lock Showing Compensating Spindle

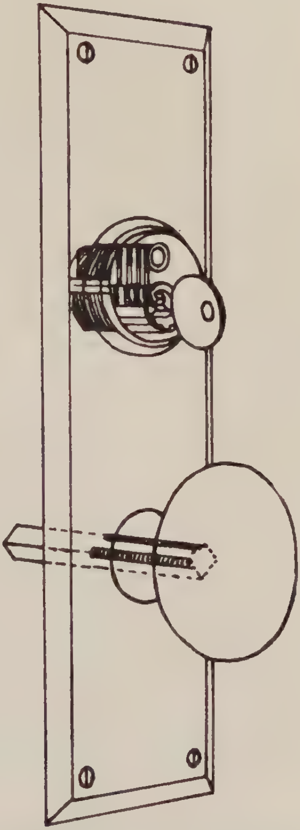


Illustration No. 52—Escutcheon and Knob for Outside of Cylinder Front Door Lock Showing Lock Cylinder in Place to the level of the top of the plug. If some are too long they may be filed off smooth while the plug is held in the **thimble.** Then the plug is ready, and the cylinder can be assembled. Try the key several times, shoot in a puff or two of graphite, and the cylinder can go back to its lock.

32. "SETTING UP" A CYLINDER

When it is necessary for any reason to remove the upper pins or **drivers** from a pin tumbler cylinder, much time can be saved in replacing the springs and drivers by following the directions below.

First insert the **following tool** in the empty shell. Pull it about halfway out until three pin holes are visible by looking into the front of the plug hole. (See Illustration No. 53) With the tweezers (See Section III) place a spring in the third hole, and then a driver on top of it, pushing the driver down until the **following tool** can be slid over it to hold it in place as in Illustration No. 54. Proceed in the same manner for the

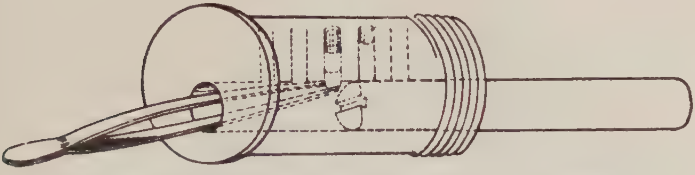


Illustration No. 53—First Step in Setting up a Cylinder

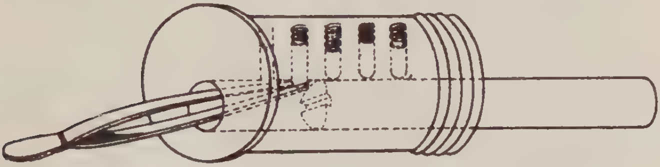


Illustration No. 54—Second Step in Setting up a Cylinder

second and first hole. Then pull the rod through the cylinder to the opposite end and set up the other two or three pins in the same way from the back of the cylinder, starting with the fourth pin from the front or **bow** of the key. (See Illustrations No. 55 and No. 56)

Occasionally a cylinder will be brought to the locksmith with the explanation that there are no keys to fit it. The first problem in this case is to **get the cylinder open so the plug can be re-**

moved. Since there is no key, a professional method must be applied.

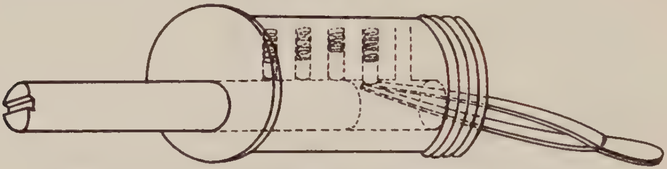


Illustration No. 55—Third Step in Setting up a Cylinder

One way to crack a cylinder under such circumstances is to insert a short length of very fine flat steel spring wire (ask your watchmaker for a piece of broken watch spring) between the **plug** and the **shell** from the back of the cylinder, meanwhile working a blank key gently back and forth in the keyhole to move the pins up and down. As each division point is brought even with the spring wire, the steel can be pushed in a little farther, until all the pins are separated. Then the plug can be turned very slightly, the spring withdrawn, the following tool set in place, **and the plug removed as if it had been opened with a key.**

Sometimes, however, especially on newer

cylinders, there is not enough space between plug and shell to permit the flat steel to enter. **Then it is necessary to rap the cylinder to open it.** In using this method, the cam is removed and the cylinder held in the left hand with the keyhole **down,** and the thumb exerting an outward pressure on the plug. A few sharp blows of a light wood or plastic hammer will sometimes jar the pins into the open position. Don't let the plug slide out too far before it is turned and above all don't hammer the cylinder with a metal hammer.

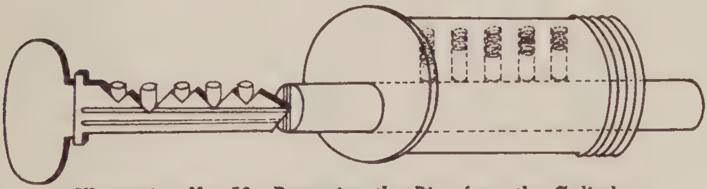


Illustration No. 56—Removing the Pins from the Cylinder

This method is by no means fool proof, and depends for its success largely on the skill of the operator in acquiring the knack of wielding the hammer, and on the setup of the pins in the lock. Sometimes even a beginner can crack the cylinder with the first or second blow, and other times an expert can hammer till his hand is black and blue without any luck. When the cylinder has been opened by one of these two methods, the next step is relatively easy.

If the combination is not to be disturbed, a blank is selected to fit the keyhole, and round-bottomed grooves are filed in it under every pin tumbler segment **until each is exactly level with the top of the plug.** When this has been done, the hills and valleys in the key should be smoothed out slightly so as not to leave any sharp points on the key that will hinder its entering or leaving the cylinder. No slope on a pin tumbler key should be at an angle greater than 45 degrees from the horizontal.

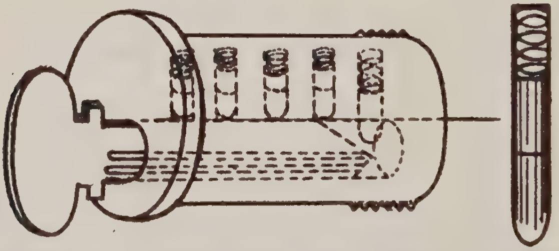


Illustration No. 57—Complete Cylinder Being Opened by Inserting a Thin Piece of Watch Spring from the Rear while a Blank Key is Used to Level each Tumbler, beginning with the Back Tumbler

33. REPAIRING PIN TUMBLER LOCKS

Probably 90% of the trouble locksmiths are called upon to repair in pin tumbler locks is confined exclusively to the cylinder itself.

But the simplest source of trouble, although a common one, **is a loose cylinder set screw,** which lets the whole cylinder turn when the key is inserted, instead of holding the cylinder in an upright position while the plug rotates inside it.

Quite often a key is hard to insert in the lock or it may be difficult to remove. A number of factors can contribute to this situation. First check the key for sharp points or rough spots. Then remove the cylinder and see that the cam screws are tight. If they are loose, or the plug is too long because of wear on the cylinder, the trouble has been located. Remove the cam and very slightly shorten the plug by a gentle stroke or two of a flat file. This will make the plug fit tightly and prevent its backing out when the key is withdrawn.

If the operation is still not satisfactory, soak the cylinder in gasoline or cleaning solvent. It may be that someone has gummed it up by oiling it. After the gasoline has thoroughly dried out, **a shot of graphite should do the trick.**

This gasoline cleaning is especially desirable at regular intervals on public buildings, hotels, and apartments where brass polish accumulates in the lock, and in spare tire and rear deck locks on automobiles which are susceptible to failure at critical times because of road dust and oil film. It can best be accomplished with an ordinary blow torch. Pump up the pressure on the cold torch, and direct the small steady stream of liquid gasoline into the keyhole. Run the key back and forth a few times to cut the dirt, and then rinse with another stream of gasoline.

Poorly fitted or worn out keys create their share of trouble in these locks just as in any other kind. When new keys are fitted to an old cylinder it is always a good plan not only to replace the lower pins, but the **upper ones,** or drivers, **and even the tumbler springs,** unless they retain sufficient tension to actuate the pins properly. A dead pin-tumbler spring, especially on a lock not mounted on an upright door, can cause all kinds of trouble.

Pin tumbler locks themselves, exclusive of the cylinders, are usually a great deal more complex than any other type. Perhaps front door entrance sets on residences give the greatest amount of trouble.

Those equipped with handles on the outside are especially vulnerable to operating irregularities. The thumb piece, after a few years, bends from use, and the latch, consequently, does not retract far enough to open the door when the thumb piece is depressed. Usually straightening or reinforcing the thumb piece puts the lock in operation.

Cylinder locks equipped with knobs on both sides frequently have spindle trouble. The swivel on the jointed spindle has to be kept ex-

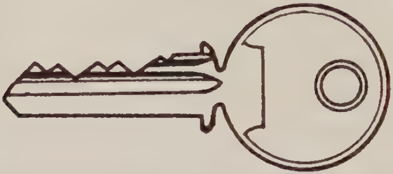


Illustration No. 58—A Pin Tumbler Key Weakened by a Low Cut Near the Bow

actly in the center of the two-piece lock hub or the nightlatch feature of the lock won't work properly. (See "inside escutcheon", Illustration No. 51) Wear to knobs or loose set screws often move the spindle either in or out. Although a great inconvenience to the layman, this situation is **easily corrected by the locksmith.** Merely center the spindle, being sure to unscrew the two sections of it far enough to insure their not jamming together when the knob is turned.

34. CAUTIONS TO BE OBSERVED WHEN WORKING ON PIN TUMBLER LOCKS

Pin tumbler lock cylinders should always be lubricated with powdered or flaked graphite, never with oil. Dust and grit will stick to any liquid in the lock and soon cause gumming.

Then tumblers move sluggishly, keys don't fit properly, and may not operate the lock at all. Graphite, however, **should not be used too freely.** An overdose can be harmful, just as a medicine could be to a person. It's messy stuff to work with—use it sparingly and wisely. After the graphite is applied, work it in thoroughly by running the key quickly back and forth in the lock. Probably the handiest way to use graphite is in the air gun type of applicator. These are available at almost any hardware store from twenty-five cents up. (See Section III)

Some manufacturers are in the habit of drilling all their standard mortise cylinders for 6 pins, even though stock cylinders are ordinarily equipped with only five. Pay particular attention to this possibility in disassembling a cylinder. If there is one tumbler missing when you take out the plug, by no means put in one when you change the combination unless you also add a spring and driver in the shell to actuate the extra tumbler.

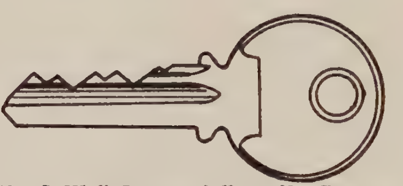


Illustration No. 59—A Well Designed Key—No Cuts too Low, Plenty of Variation in the Cuts

Sometimes when a cylinder is dismantled it will be discovered that there are more than two pin segments in each tumbler. Such a situation indicates that the lock is **masterkeyed.** Great care should be taken not to disturb the arrangement of the tumblers unless required. (See Section VIII)

When a cylinder is **cracked** either by **rapping** or springing with a fine wire, it is necessary to be cautious in removing the core. If the core is slid straight out, the front four tumblers in the shell will spring into the four rear holes in the plug, and the cylinder will be locked part way open. Whenever a core is removed, then, **it should be turned slightly before being withdrawn** to insure against this difficulty.

Occasionally after a pin tumbler combination has been changed it will be found that difficulty is encountered when inserting or removing the key. This condition is usually caused by too long a pin segment for a driver. If, for instance, the cut in the old key in No. 4 tumbler position was very shallow, there would have been a relatively long driver in the No. 4 hole to compensate for it.

But if in the new combination the No. 4 tumbler cut is very deep, the long pin and long driver would together take up so much more room that there would be no room for the tumbler spring. Replacing the driver in this case with a considerably shorter pin segment should alleviate the trouble, **but the tumbler spring should also be inspected for damage from crushing.**

Great care must be used in working on pin tumbler locks to use the correct size tumblers. Too small a segment may cause wear and jam in a crosswise position, defying all efforts to open the lock. (See Section III)

Be sure you understand a customer's directions before he leaves the shop. If he does not want a lock changed, and you change it by mistake or misunderstanding, you may cause him a great deal of trouble. Arrange some system of claim checks so locks cannot possibly be confused. Be sure to give the customer back all the parts for his lock. Don't leave the cylinder rings or escutcheon plates on the bench. (See Section III)

In switching cylinders in mortise locks to save time and trouble in combination changes, avoid putting standard Yale, Corbin, Sargent, or other .51 inch plug cylinders in Russwin or other locks intended for cylinders having a larger core. **The center of revolution, or axis, is different in these locks,** and a standard sized cylinder will not satisfactorily operate the lock intended for a different cylinder. Also note that the new Russwin cylinders have a special shaped **"cloverleaf cam",** which cannot be used in other standard locks.

Keys for pin tumbler cylinders should whenever possible be cut from key blanks furnished by the manufacturer of the lock itself. Such a blank, known to the trade as a **genuine,** eliminates many of the dangers of imitation blanks. Some imitations are good; others are not. (See Section III)

Removing cylinders from mortise locks is sometimes a problem, especially if the cylinders refuse to come out after the set screw is loosened. Never put a pipe wrench or pair of pliers on a cylinder. Such procedure not only mars the cylinder and scratches the door, but brands the wrench wielder as a rank amateur if not a **butcher.**

If a cylinder won't unscrew, any of the following operations should aid in its removal. Place a scrap key or a key blank in the keyhole, and if necessary, use the pliers on the key. If it still turns hard, loosen the escutcheon plate if there is one and **remove the screws that hold the lock in the door.** A gentle tapping on the face of the lock case with a light wood or plastic hammer should bring the cylinder out without any further trouble. Always put a thin coating of cup grease on the first few threads of a cylinder when replacing it to facilitate easy removal in the future.

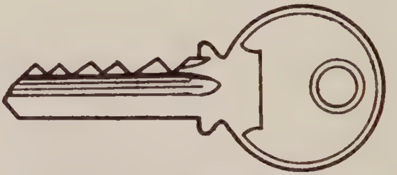


Illustration No. 60—Cuts are too Nearly Same Depth. A Pen-Knife or Hairpin could be Used to Level the Tumblers

In preparing keys for changing pin tumbler lock combinations, there are two things to avoid. Never let the first cut near the **bow** be more than of medium depth. To cut away the key at this point to a No. 8 or No. 9 cut materially weakens the key and invites trouble. Many persons have a tendency to exert a turning pressure on the key before it is all the way in the lock cylinder. A key with a low cut near the bow, then, would easily twist off, leaving a piece of key in the lock. (See Section III)

Never arrange a combination as shown in Illustration No. 59. Here all the tumblers form almost a straight line across the key. There is little resistance to opening, for instance, by leveling the tumblers with the small blade of a pen knife.

SECTION VIII

MASTERKEYING

35. GENERAL DISCUSSION

In general terms, a masterkeyed lock is one which is operated not only by its own individual key, but also by a **master key** which opens a given number of individual locks. The individual key for each lock, under such a system, is known as a **change key, occupant's key, guest key,** or **tenant's key** depending upon whether the building covered by the master key system is a store, apartment, hotel, or office building.

The master key is held by the custodian, manager, janitor, or superintendent to enable him to get into any room in the building for cleaning, repairs, etc., without having to carry a separate key for each room.

Before going further with a discussion of masterkeying, it should be understood that there is no relation between a **master key** and what is commonly termed a **pass key.** A lock operated by a **master key** is **set up** at the factory or by a qualified locksmith with the express intention and purpose of making it possible to open that particular lock with a certain definite master key furnished to **that building alone.**

A **pass key,** on the other hand, is more or less a layman's term and refers to any **skeleton key** or **pick key** that can be made to operate an inexpensive or lower grade lock by wiggling it around in the keyhole until it happens to catch the single tumbler in just the right place. A lock opened by a **pass key,** then, was not intended to be so operated by the makers, although they may have known such operation was possible.

Masterkeying, because of its very complex nature, is almost exclusively confined to better

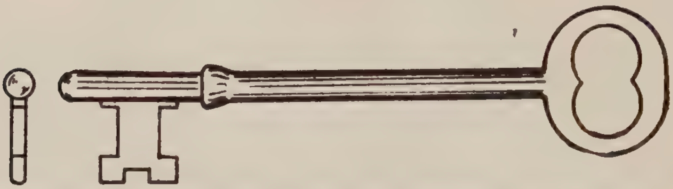


Illustration No. 61—One Type of Pass Key (Also see Illustration No. 29)

grade hardware, especially lever tumbler and pin tumbler locks.

On very large buildings, or in well managed hotels, it is sometimes desired to limit the janitors' or maids' masterkeys to rooms on the floor or floors for which they are directly responsible, so as to keep a dishonest employee from premises he cannot be held strictly accountable for. Under such conditions, the lock factories furnish **sub-master keys,** or **maids' keys** for each floor or division of a building, and a **grand master key** (for the superintendent or building manager) which passes all the locks on all floors.

In addition to the **grand master key,** some hotel and apartment managers keep an **emergency key** which is really a **super-grand master key.** The emergency key quickly opens every door in the building, even if it is locked from the inside. This key is used only by the manager himself in unusual cases such as fire, illness, suicide, or similar emergency situations where the guest has locked himself in a room and is unable to let himself out.

Traveling salesmen using a hotel room to display samples of valuable merchandise often desire to have the rooms locked while they are out so that even the master key will not admit trespassers. Under such conditions the salesman is issued an individual emergency key, called a **display key,** with which he can lock the door so that no key but his own and the manager's **emergency key** will open the door. In this way, bellboys, maids, and building employees are absolutely locked out.

36. LEVER TUMBLER VS. PIN TUMBLER MASTER KEY SYSTEMS

As mentioned before, both lever tumbler bit key locks and pin tumbler locks are readily adaptable to masterkeying.

One single circumstance, more than any

other, decides which type shall be used in a particular installation. The question that must be answered, then, is the amount of security desired or required. Other factors entering into consideration are initial cost, installation expense, cost of key replacements, and adaptability to easy combination changing.

Manufacturers themselves make clear the fact that the pin tumbler mechanism is the best for masterkeying purposes, but the best grade bit key lever lock also has its good points under certain conditions.

Chart No. 2 points out the relative merits of the two types of locks for masterkeying purposes.

Perhaps the strongest criticism against the security of the lever tumbler bit key lock in a masterkeyed system lies in the fact that master keys for these locks are generally **standard** or **stock** master keys. In other words, the master key furnished for a particular job by a given manufacturer has also been furnished to many other buildings, some of which may be in the

CHART NO. 2

	Pin Tumbler Lock	Lever Tumbler Bit Key Lock
Initial Cost	Relatively high, but reasonable considering security offered.	⅓ to ½ that of pin tumbler locks of comparable size and design.
Installation cost	Standard types of these locks are among hardest to install from point of view of time used, even by experts. New unit locks and single bore locks quickly installed by any carpenter.	High because of large case. Takes 2 to 3 times as long to install as new unit-built pin tumbler locks.
Maintenance expense	Should be very low—castings mostly of bronze.	Usually runs higher because large case itself and many parts are of cast iron.
Combination changing	Easily accomplished by removal of cylinder only.	Necessitates removal of lock from door and should be attempted only by factory trained expert if master key is to work new combination.
Specific advantages	1. Unparalled security 2. Every master-key different	1. Lock not so easily fouled with gum, matches, toothpicks, etc. (Better for institutional use) 2. Can be readily applied to thin doors (1⅜″ or thicker.)
Specific disadvantages	1. Mortise type usually not adapted to thin doors because of greater thickness of case.	1. Adapted to relatively small installations only because of limited number of key changes.
Main uses	Large hotels, public buildings, apartment houses, office buildings, exterior locks on schools, etc.	Smaller hotels, dormitories, interior doors in school buildings, classrooms in universities, steamship staterooms, etc.

same general vicinity or district. Consequently, it has often been found that a master key from a grade school building often fits all the classroom doors on a near by high school, or vice versa.

Pin tumbler locks on the other hand, are prepared for an individual building **with a special master key fitting only the locks in that particular building** or group of buildings as may be directed by the customer. Every lock manufacturer keeps complete and accurate records of master keys issued by him, and the location of buildings on which the locks are to be used. In this way, it is possible to be certain that no two buildings in a given state or group of states have masterkeys that even approach being similar.

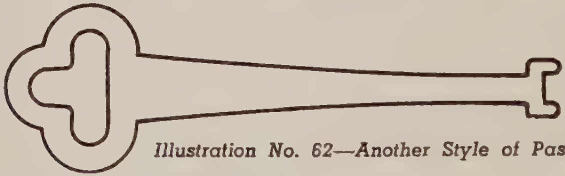


Illustration No. 62—Another Style of Pass Key

37. MAPPING OUT A MASTER KEY SYSTEM

In planning a master key system, many factors should be considered. In the first place, the probable number of possible different locks that might be required in the future should be taken into consideration so as to allow for expansion.

Key control is in itself quite a study. The problem of what key shall be made to fit which locks may seem simple to the layman, but **many problems present themselves** when such a question is considered by the architect and lock engineer.

For instance, in apartment buildings, should trunk storage rooms be operated by every tenant's key, or only by a key that must be obtained from the manager's office? Should all tenant's be able to operate the exterior door locks of the building with the same keys that open their individual apartments? In public buildings, should lavatories and wash rooms be accessible with office door keys? These and a hundred other similar questions have to be considered in properly laying out a master key system of even moderate size.

Although it was a popular practice for many years to provide apartment buildings with exterior locks that could be operated by every tenant's key, lock consultants have begun to discourage the practice. Although it is still done, especially on buildings where cost is a deciding factor, **most architects now realize that the plan is not a good one.**

In the first place, in order to make a lock operative by a number of keys, each of which is different from any other, a great deal of the lock's original security must be sacrificed. In pin tumbler locks all the pins but two or three are removed, and these are cut at various places to allow for different depths of tumbler cuts. Under such circumstances, **almost any key that will enter the keyhole will operate the lock.**

Since an exterior lock of such a building receives as much use as all the rest of the locks combined, it wears out faster, and soon begins to bind and scrape on keys, **causing them to fit poorly in their individual locks.** The thin master-discs in the lock wedge sideways in their holes, and guests begin to complain about key trouble. Then somebody discovers he can open the lock by inserting his knife blade in the keyhole. He tells other tenants, and when a sneak thief enters an apartment window the victim feels sure the front door lock is to blame. The building may find itself facing a law suit, and tenants begin to talk about moving out.

By far a better plan, then, is to have a separate and distinct key for the exterior doors, with even the keyway different from the interior locks. Have the cylinder combinated with all five or six pins in it to really offer some security. Tenants don't mind carrying an extra key if they realize it is to their own advantage.

The same applies to community trunk rooms and storage closets. If the apartment renter has to get a special key from the custodian each time he enters the room, **the manager has some way of telling who was where when something is missed by another tenant.**

Lavatories and rest rooms in public buildings can be provided for in the same way. Since many employees are not given office keys by their employers, there is little advantage in having office keys operate rest room locks. The much better plan is to provide all the women's rooms with keyed-alike locks and all the men's rooms with keyed-alike locks of a different change number. Each office or room in the building, then, is provided with two wash room keys, appropriately labeled, one for each sex. These are kept where each staff member can easily get them without embarassment, and put in that particular place when returned.

38. MASTERKEYING LEVER TUMBLER LOCKS

Since lever tumbler locks are almost always masterkeyed at the factory, it will be necessary only to explain the manner in which this is possible.

Most masterkeyed lever locks have what is known as a master lever, usually the bottom one, which holds a **master pin** or other device which carries other levers along with it when the one lever rises. The master key then, is cut away so as not to interfere with other levers, but only to raise the master lever to the required position. When the master lever is raised, it takes with it the other levers which rest against the master pin, and the lock is opened.

Another popular plan, especially on better grade locks, is to have two gates cut in each lever in the lock. The proper **change key** sets all the bottom gates even with the bolt post, and **master key** puts all the upper gates in the same position.

39. MASTERKEYING PIN TUMBLER LOCKS

The actual performance of the work in masterkeying a cylinder is not so difficult or intricate as might be expected, although care and attention must be given each operation.

Essentially, masterkeying consists of putting and extra pin segment, called a **master key disc,** in each pin hole to equalize the difference between the master key depth and the change key depth in each tumbler position.

First prepare the two keys, noting the following cautions:

1. Every tumbler depth in the change key should vary at least three cuts from the corresponding tumbler depth in the master key. This is to avoid filling the cylinder with very thin discs which might wedge themselves in between the plug and shell and consequently jam the lock. A good rule is not to put any discs in that are not as long as one-half the diameter of the pin segment itself. On very large and complicated systems, this cannot be avoided, but it is best for the novice not to attempt it. If the first pin in the change key is a number 3 cut, for instance, the master key should be cut to at least number 6 or left blank (no cut at all).
2. If it is thought that the system when complete will have more than a half dozen locks in it, every pin in each

change key should be either deeper or shallower than the corresponding cut in the master key, never the same depth.

3. Don't cut all the master key cuts below the change key combinations. Alternate the cuts so at least one point on the master key is higher than the corresponding cut on the change key. This **prevents an unauthorized person from making a master key** from his change key in case he ever gets momentary access to the master key.

Now that the keys are ready, proceed as follows:

Compare the two keys. See which cuts on the change key are shallower (or higher) than corresponding cuts on the master key. Assume, for example, that cuts 1 and 4 (counting from the bow of the key) are so made. Insert the change key in the lock plug, dump out all the old pins, and place new pins in holes 1 and 4. File these down even with the top of the plug. Now remove the change key, and insert the master key, placing pins in the other cuts, or numbers 2, 3, 5. When these have been filed down, fill in the spaces in cuts 1 and 2 with cylindrical pin seg-segments flat on both ends and long enough to reach the surface of the plug.

Now with the tweezers place these pin segments in the **laying out board** in their proper position, and again insert the change key in the plug. Now there will be empty spaces in holes No. 2, 3, and 5. When these have been filled with masterkey discs and levelled remove the key and place the two pin-segments which have been put aside on the **laying out board** in their proper places in the plug, and assemble the cylinder. Both keys should work. If one sticks, disassemble the cylinder with it and smooth the top of the pins with the fine file, taking care not to press too heavily lest the other key refuse to work as a result. The customary light dose of graphite finishes the operation and the master-keyed lock is ready for service.

40. SPECIAL MASTER KEY SYSTEMS

Very large and complex master key systems sometimes require more key changes than it is practical to make with one keyway. In such cases, Yale, Sargent, Russwin and a number of other companies make use of what is known as the **security system** of master-keying. Under such a plan, all the locks on one floor or in one division of a building are equipped with a differ-

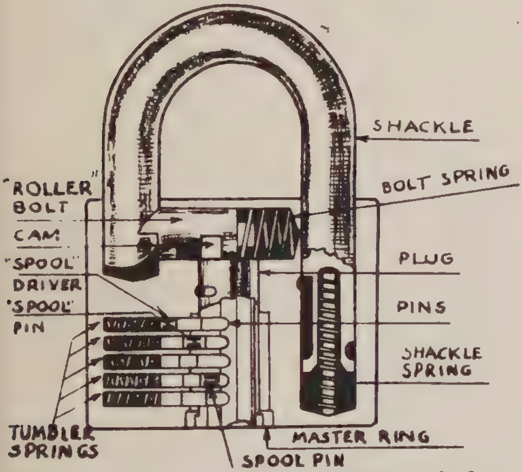


Illustration No. 63—Cut-Away Section of the Corbin Pin Tumbler Padlock

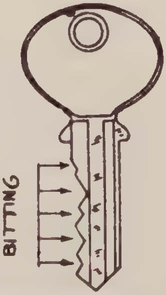


Illustration No. 64—Key for Padlock in Illustration No. 63 ent keyway, and **submaster keys** for these locks are also cut on the keyways in use in the particular division. The **grand master key,** however, is cut on a blank which is thin enough to enter all the various keyways used in the building. This plan has several advantages. It not only prevents keys from one floor operating other locks on a different floor, but keeps them from even entering the keyhole.

The Corbin company uses a special large size cylinder in its master key work that absolutely eliminates the danger of "splitting" the combination with an unauthorized key. This method makes use of an extra **master key collar** or sleeve in the cylinder just outside the plug, and the master key or keys set the combination on the master sleeve.

It will be seen, then, that such a system, employed exclusively by the **Corbin** people, **makes it impossible for a stray key to split the combination.** Where an ordinary cylinder masterkeyed on five pins could have thirty-two separate and distinct keys made that would fit it, (2^5 or 2 to the fifth power) a cylinder using the master keying methods employed in the **Corbin** large size cylinder could be opened only by its own change and master keys. This extra security may seem over-important, however, until we realize that an extra thirty chances in 100,000 for an unauthorized key don't really affect the security of a lock to an appreciable degree.

41. ADVANTAGES AND DISADVANTAGES OF MASTER-KEYED LOCKS

No discussion of the principles of masterkeying would be complete without a consideration of the merits of the plan.

The first and most important point in favor of masterkeying a series of locks is of course **the element of convenience.** In a large office building for example, much time and energy would be wasted if janitors and building employees had to carry large and bulky key rings containing separate keys for each office or suite. The only other alternative, if a masterkey system was not in use, would be to keep a file of duplicate keys in the building office, accessible to employees. **Great confusion would be sure to result in either case.**

Another important factor is that concerning the **safety** of the tenants and their property. Visualize the building staff fumbling through a ring of fifty or one hundred keys to get into a securely locked room from which a broken water main was sending torrents of water to the floor below. For the protection of all concerned, some authorized person must be able to enter the premises without delay under certain circumstances. **Masterkeying provides the answer.**

On the other side of the ledger, however, we find a few disadvantages.

In the first place, a certain amount of **security** is necessarily lost under a masterkeying plan. As pointed out before, masterkeying a pin tumbler lock increases the number of points at which the tumblers are separated, which naturally increases the chances of the lock's being opened with an unauthorized key.

This is not the greatest threat to security, however. The possibilities of mechanical vulnerability can be accurately computed. **It is the human element that creates the danger.** Since the relatively high cost and great inconvenience to tenants in most cases practically prohibits the changing of all lock combinations and the establishment of a different master key setup from time to time, building executives are apt to overlook the fact that unauthorized masterkeys may be in the hands of former employees.

Many organizations make an earnest attempt to eliminate this possibility by requiring all employees to deposit their keys in a locker or safe before leaving the building for home. No method can be devised, nevertheless, that will keep a duplicate masterkey from falling into the hands of a person who is even temporarily entrusted with it, if he makes up his mind to have one. For this reason, great care should be exercised in the selection of employees who are to have access to master keys. Subordinate workmen who are on a part-time or on-call basis should generally work under a supervisor rather than be issued a master-key themselves.

Another definite weak point in the master-key plan is the effect it has on the tenant's attitude toward the building. **Some persons resent the fact that building employees are able to enter their rooms at any time,** and are apt to be inclined to blame the building if losses should occur. This feeling can usually be overcome, to a great extent at least, through a courteous explanation by a responsible official of the building that such a plan is necessary for the protection both of the building itself and the property of the tenant which may be in the building.

RESTRICTED KEYWAYS

One of the greatest problems of protecting lock security has always been the control of unauthorized keys. Where it is considered essential that those entrusted with certain keys be unable to secure duplicates for their own use, lock manufacturers have devised a series of **re-**

stricted keyways. Under this plan, the cylinder of a pin tumbler lock is equipped with the desired number of keys, cut at the factory on blanks which are not available to the trade. The theory is that no private individual can secure duplicates or blanks with which to make duplicates. Additional keys are furnished by the lock maker from code number **upon written order by appropriate authority.** This plan has been used extensively by government agencies, including the Army and Navy, and certain other departments where absolute security is thought necessary.

The idea itself is out of favor with most present day experts, however, for several reasons.

In the first place, notwithstanding copyright and patent laws, some blank key manufacturers may soon learn of the installation, secure a sample, and promptly offer blanks to the trade. Although the original factory keeps its word by refusing to sell blanks, they are quickly made available, through other channels. Often these "counterfeits" are poorly machined and not accurately milled to fit the locks for which they are intended.

Another complaint is that reputable local locksmiths, when blanks are not generally available, are unable to furnish duplicate keys or make emergency combination changes on short notice, which may be a definite inconvenience to departmental heads and their purchasing staffs. Even on proper authority, then, the **red tape** and **time element** involved in factory orders **make these locks a nuisance** in many cases.

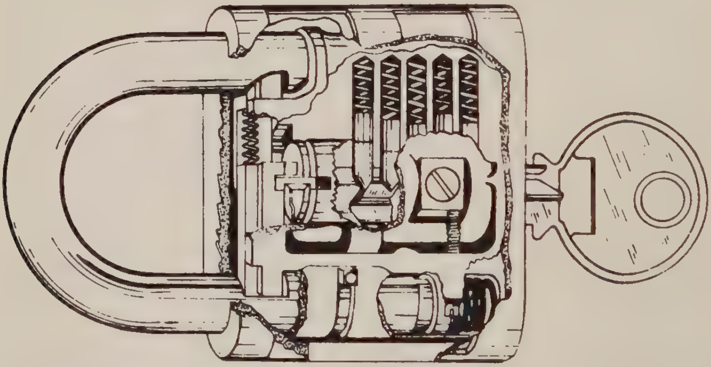


Illustration No. 65—Cut-Open View of the Yale Pin Tumbler Padlock

SECTION IX

SERVICE HELPS

43. NOTES AND CAUTIONS FOR WORKING ON A NUMBER OF SPECIAL TYPES OF LOCKS

While every lock manufacturer's product is similar to that of his competitor's in **basic design and principle of operation,** many lock makers have developed some particular type of lock as a specialty, or have some intricate deviation from general practice that makes their locks difficult to service for the person not entirely familiar with their construction. In this chapter we shall consider a few of the better known manufacturers, and discuss the peculiarities of locks marketed by each.

Bell locker locks are rapidly gaining popularity on vending machines of all types, pin ball boards, record players and similar coin-in-the-slot devices. This lock departs from the conventional and makes use of a key with two thin irregular slots milled into the sides of it. These slots receive the feelers which line up the wafer tumblers to operate the lock. Beside defying picking more effectively than most conventional locks, these locks provide additional safety by helping to control **unauthorized keys,** since ordinary key machines cannot duplicate them and most shops do not have the special milling tools for making copies of them.

The **Best Lock Company** features the Best interchangeable core. This company manufacturers cylinder locks exclusively, and provides each with a removable **core** which contains all the pins and tumbler springs, as well as the plug. These cores are easily removed from any lock by use use of the **control key,** and can be inserted in any other lock made by the company, whether it be a padlock, drawer lock, cylinder nightlatch, or unit lock. The advantage of this feature is the ease with which combination changes can be made by authorized persons without calling a locksmith. The old core is removed and a new one or spare inserted in the cylinder, and presto — the old keys no longer fit.

Most of the locks sold by this firm go directly to large oil companies, steamship lines, municipalities and public utilities where **security control is important.** Retail distribution is limited since the average layman finds no necessity for the interchangeable core feature.

The **Briggs and Stratton** people in their lock division specialize almost exclusively in locks for automobiles, including ignition, door, spare tire, and baggage compartment locks and latches. The side bar principle in these locks as used in the present day General Motors vehicles, is a great improvement over the double-bitted type of key used on older models.

The **Chicago** lock people have a wide variety of special locks in use throughout the country. Perhaps the most popular is the Chicago "Ace", used extensively on parking meters, soft drink dispensers, etc. This is a **pin tumbler lock** having a large tubular key with the cuts for the pins around the rim of the key. The tumblers are brought into line by the key being forced against them as it is inserted.

Other **Chicago** locks include numerous wafer tumbler and multiple security devices for protecting coin boxes on almost every kind of vending machine. This company was one of the first to use the continuous tumbler idea, where the tumblers fill the whole inside of the core one after the other.

The old style Chicago cylinder lock had a peculiar pin tumbler mechanism. The tumblers, instead of being divided **horizontally,** were split **vertically.** The keyway was shaped in the form of an "H", and the change key was a ladder down one side, and the master key was the reverse section of the change key. Needless to say, these locks were not well received by the trade, since re-keying and service work required not only special tools and a supply of factory cut pins, but painstaking effort.

Corbin's special feature is the special master key system they employ, consisting of a special outer master key ring in addition to the regular key plug. (See Section VIII).

Crown locks were used for a while on Ford autos, and later on certain metal office furniture. Consisting essentially of a peculiar type of four pin lock in a die cast case, these were not very popular because the metal in the die castings tended to swell and "freeze" the tumblers.

Dexter locks, a product of the National Brass Company, are usually of tubular construction, and the disc tumbler models, particularly, generally have die cast parts.

Dudley Lock Company recently developed a double bitted key milled out half the thickness of the blank on both sides. The locks equipped with this key are sold under the supposition that no one is able to duplicate the keys except the factory. Indeed, this "key control" system is as good as any, but cannot, of course, be foolproof. Keys can be and have been duplicated, **although the labor cost and time involved make it unprofitable except in special cases.** This firm also manufactures padlocks, including a popular seller in the combination line for school lockers.

The **Illinois** lock, strangely enough, like the Chicago, is popular on vending machines, record players, and parking meters. Utilizing the principle of the disc tumbler, double bitted key, these locks prove very effective due to their carefully corrugated keyways.

The **Schlage Lock Company** has perhaps the widest line of general purpose locks in the tubular or "bored in" field. Although confining themselves to the manufacture of locks for regular thickness doors (1-3/8" to 1-3/4" and up) and a few padlocks, the firm has available a complete selection of locks for almost any conceivable purpose, most of them interchangeable in the same mortise. For private homes, hotels, public buildings, apartments, service stations and, in fact, every need, Schlage locks are available in a variety of price ranges.

The "A" types Schlage lock, perhaps the most common, uses the wafer tumbler key as discussed in Chapter VI. The "F" type is a light, compact disc tumbler lock, while the "C" and "D" locks are heavy duty pin tumbler locks, the "C" grade being entirely of rust proof material and intended primarily for marine installation. These mentioned so far are all unit type locks mortised into the door by two holes, one through

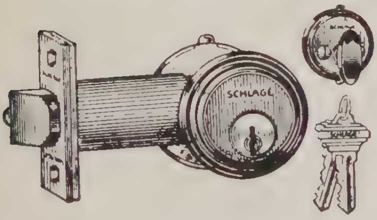


Illustration No. 66—Schlage Deadlatch

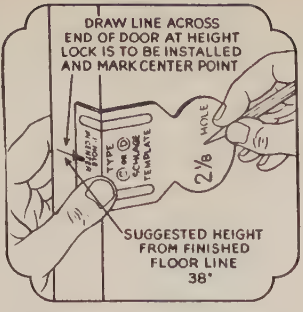
Illustration No. 67—Schlage Lockset, Novo Design the face for the lock and one in the edge for the latch.

All these locks, including the "E" type, or front door handle set, are easily removed from the door, not in one piece as in many unit locks, but by first removing the inside knob and trim and then taking out the lock from the outside of the door.

For "A" type locks, proceed as follows:

1. Locate small spring catch on inside knob. Depress this with small screwdriver and at same time exert a pull. Knob should easily slide off.
2. Then locate spring clip that holds inside escutcheon plate on. By holding this down, you can easily pry off the plate, exposing the backplate.
3. Remove the two connecting screws, and then slide the latch guard disc up or down as the case may be, to let the lock slide out of the door freely from the outside.

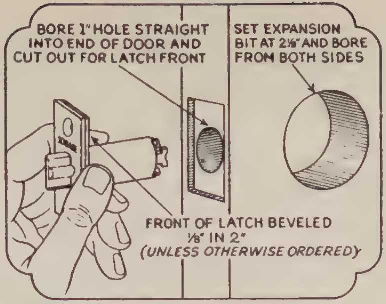
(1)—MARK DOOR


DRAW LINE ACROSS END OF DOOR AT HEIGHT LOCK IS TO BE INSTALLED AND MARK CENTER POINT
1" HOLE IN CENTER
TYPE
SCHLAGE TEMPLATE
2⅛ HOLE
SUGGESTED HEIGHT FROM FINISHED FLOOR LINE 38"

Place template on high edge of bevel at *height line* (center line of latchbolt and knob), and press firmly against door. Spot center for 2⅛" hole.

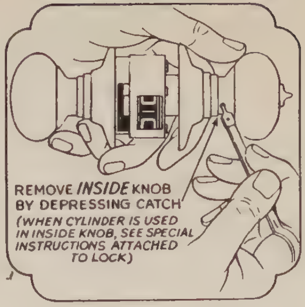
Backset 2¾" unless otherwise ordered.

(2)—BORE HOLES


BORE 1" HOLE STRAIGHT INTO END OF DOOR AND CUT OUT FOR LATCH FRONT
SET EXPANSION BIT AT 2⅛" AND BORE FROM BOTH SIDES
FRONT OF LATCH BEVELED ⅛" IN 2"
(UNLESS OTHERWISE ORDERED)

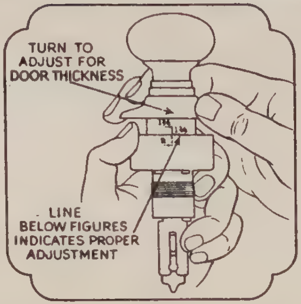
Bore 2⅛" hole in face of door at point spotted through template. Then bore 1" hole at center point on *height line*. Insert latch unit in accordance with swing of door and put in screws.

(3)—REMOVE INSIDE TRIM


REMOVE *INSIDE* KNOB BY DEPRESSING CATCH
(WHEN CYLINDER IS USED IN INSIDE KNOB, SEE SPECIAL INSTRUCTIONS ATTACHED TO LOCK)

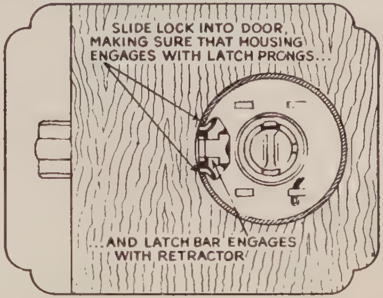
Insert pointed end of spanner wrench through hole in knob sleeve on side facing latch retractor. While exerting pressure on spanner wrench, slide knob off of spindle. Then, remove escutcheon by rotating to left (reverse of action in Illustration 6).

(4)—ADJUST DOOR THICKNESS


TURN TO ADJUST FOR DOOR THICKNESS
LINE BELOW FIGURES INDICATES PROPER ADJUSTMENT

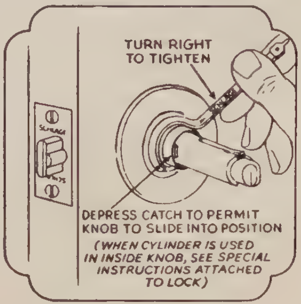
If necessary, adjust lock to the correct door thickness by rotating outside escutcheon until proper door size appears above edge of housing. Be sure to leave it set at a point where it is engaged with ratchet.

(5)—INTERLOCK LOCK & LATCH UNITS


SLIDE LOCK INTO DOOR, MAKING SURE THAT HOUSING ENGAGES WITH LATCH PRONGS...
...AND LATCH BAR ENGAGES WITH RETRACTOR

Lock unit should always be inserted from the outer side of the door.

(6)—ATTACH INSIDE TRIM


TURN RIGHT TO TIGHTEN
DEPRESS CATCH TO PERMIT KNOB TO SLIDE INTO POSITION
(WHEN CYLINDER IS USED IN INSIDE KNOB, SEE SPECIAL INSTRUCTIONS ATTACHED TO LOCK)

Thread on inside escutcheon using spanner wrench to tighten it firmly against door. Slide knob into position and test fastening of catch by pulling on knob.

Installation instructions are given in the previous illustrations covering the heavier C and D type locks. These will prove helpful in understanding the construction features of this type of lock. It should be remembered, however, that cylinders of these heavy duty types can be easily removed for changing without taking the lock off the door. For help or advice in servicing any Schlage locks, see your local Schlage dealer or factory representative in the district.

44. CODE INFORMATION

Everyone has heard of secret codes and code books. Locksmiths, too, have a system of decoding information regarding locks and keys to enable them to write it on paper for future reference either by themselves or by fellow craftsmen.

When an automobile owner rushes into your shop with the statement that he has lost his ignition key and can't move his car, **deciphered figures in your code book come to his rescue.**

While many localities require by law certain formalities, such as police reports of such circumstances, here is what might happen in a typical case.

First you inquire if the motorist has access to record numbers of the keys to his car. These are either attached to the ring new car keys come on, or they are stamped on the keys on removable plugs which can be punched out and saved for future reference. If the motorist can go to his safety deposit box or look in his wallet or on his car owner's service policy and get these important numbers, you can furnish new keys in a few minutes.

Let us assume he is a **wise** motorist and carries such information in his wallet along with the serial number on his watch, automobile motor number and other important data. All you have to do is look up in your **code book** the number he gives you, put a blank in the key machine and cut a key according to the pattern indicated.

Many persons think that locksmiths make keys from code by looking at pictures of the keys.

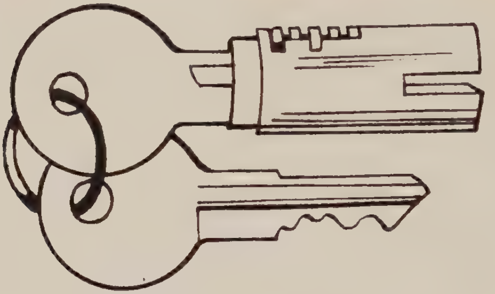


Illustration No. 74—Core from Lockset Type

This is not the case except in special circumstances where numerical or lettered information will not serve the purpose, as in certain double bitted keys and many trunk keys.

If, for instance, the number the autoist gives you is XF1321, you must look up the XF series in your book. "For 1945 Knockabout cars", you read, "use blank number so and so", say the instructions. "Guide key set No. 4A. Cut from the **bow."** Then looking down the list you see 1321 followed by a 34313. That is the code. You put the proper blank in the machine, follow the instructions for that particular code, **and presto**

—you have a duplicate of the lost key.

By this example you can see the great aid that codes can be to the locksmith. They save him many troublesome outside calls, since he can oftentimes make the key in the shop instead of going out on a service trip to open the lock and fit keys.

Even in the shop, codes save time and trouble. A boy brings in his bicycle padlock, a good one his father has given him, but all the keys are lost. Instead of going to the trouble of taking the lock to pieces, **you can look for a code number and make a key without touching the lock.**

On a recent occasion I was called by the paymaster of a large contracting firm at work on an army cantonment in a small town some miles from the shop.

"Our payroll records are locked in a new filing cabinet," said the telephone voice. "Can you come right out and open it up? If we don't issue checks today we'll have a strike on our hands. This is a government job, and we can't lose any time."

When I asked the man for details he explained that an office girl did not understand the drawer had a spring lock, and had closed it before going to lunch while the keys were inside.

"What kind of a file do you have," I inquired, hoping to save a costly trip and yet help him out.

"It's made by the John Doe Company," he answered after a hasty look. "The number on the lock is 622. Does that help?"

"I'll have a key there in an hour," I answered, reaching for my code book while still hanging up the phone. **In ten minutes a special motor messenger was on his way to the camp with a new key,** and I soon had another call from the paymaster verifying that everything was all right.

Lock codes are divided into two main classes, commercial and secret. Some manufacturers put numbers on their locks that any locksmith can cut a key from, even without a code book. These are known as commercial or trade codes. No special information is required to use them, and no attempt is made by the manufacturers to prohibit their use by legitimate locksmiths.

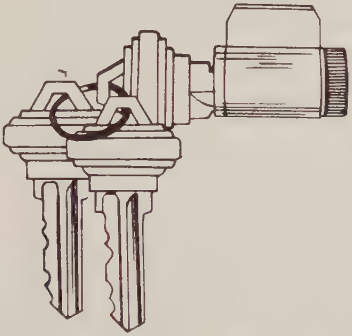


Illustration No. 75—Core from Pin Tumbler Type Lockset

Other manufacturers, however, are sold on the theory that codes should be secret, and that they alone should be able to duplicate keys from the numbers. This policy no doubt results from a genuine attempt to protect their customers' interests by keeping codes out of dishonest hands, **but it often results in a real hardship in a**

case of lost keys, since few locksmiths outside the larger cities are able to afford special data compiled on these locks by cooperating experts throughout the country. Another argument is that any lock user who wants to can obliterate any code numbers on his lock with a file or emery wheel if he feels doubtful of security.

Secret codes are of two kinds, **listed** and **derivative.** In the listed code, there is no relation whatsoever between the code number and the cuts in the key. Most automobile codes are of this type. You must have the printed code sheets on the particular type of lock you are working on. If, for instance, lock number CG127 is coded as 35523, number CG128 may be 11131, or any other combination. Sometimes these codes are made available by the manufacturers, and sometimes they are not. In the latter case, **locksmiths all over the country get information on whatever keys they can and send it to a central office for recording.** Here the dope sheet is printed or duplicated and copies sent to all the members. Many codes are available only through such channels when manufacturers refuse to sell them. Many companies have discontinued secret codes for the very reason that they do not long remain secret, and locksmiths generally are not cordial toward firms they feel do not cooperate with them.

A **derivative code** is one in which some definite relationship exists between the numbers as printed on the lock and what the key looks like. For instance, if a lock was numbered ZZ1196, the code for a four pin tumbler lock might be 6911, found by reversing the rotation of the digits. Or it might be 6191, found by transposing the 1st and 4th digits. Many locksmiths spend their spare time trying to decipher new, secret lock codes of this type. **Given a few locks and the keys for them, an expert can very often see through manufacturers' attempts at secrecy.**

I recently had occasion to cut some sixty bit keys for a hotel 400 miles away from the lock numbers sent in by the manager. From a local dealer I obtained a half dozen similar keys, and

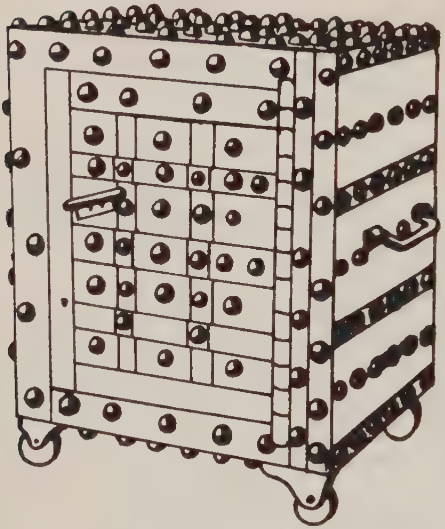


Illustration No. 76 — An early day safe, brought across the plains by a Pioneer Oregon merchant in 1852. Unlike the safes of today with their intricate combination locks, this strongbox was opened with a 3½ lb. brass key, inserted in a secret keyhole exposed when the loose band in the center of the door was slid to the right. (Note that the large bolt-heads in the center of the door are not in a straight line). In spite of its massive appearance and great weight (508 lbs.) the safe consists merely of a stout oak box covered with a thin sheet of iron, held in place by large headed tacks to give the appearance of massive bolt-heads.

after a long "puzzle session" I solved the riddle, one of the best secret codes, from a standpoint of complexity, I have ever seen.

Just to be sure, however, I cut a few and sent them away to be tried. When I got a letter that they all worked fine I cut the rest, and all fitted perfectly. Under normal circumstances such a procedure might not have been practical, but the factory was tied up with war orders, and the hotel could not spare the keys they had for samples.

Lock codes are useful in other ways. They also work in reverse. Given a key, a locksmith can generally thumb down his list and find the number of the lock the key will fit. Such a procedure has often been helpful to police officers in solving crimes where keys have been left or lost by involved persons.

Needless to say, jobbers of locksmith supplies are careful about selling codes to strangers or newcomers. Perhaps the best way to get a proper "ground school" course is to **make an arrangement with some successful craftsman** who may in time learn to know and trust you, and subsequently use his influence and knowledge to aid you.

SECTION X

SAFE, VAULT AND BANK LOCKS

45. GENERAL SURVEY

Everyone who has attended the moving picture theaters has seen the agile-fingered culprit deftly twirling the dial on a safe, then quickly reach in and find the jewels, bonds or currency.

Most of these "Light Fingered Louie" or "Jimmy Valentine" operators astonish the average layman with their ability to open massive safes in practically no time flat.

Pity the chagrin of the film studio realists, then, when some kind hearted person some day tips them off to the fact that they are letting their "villains", who are, according to most stories, without the slightest knowledge of the combination, open safes in ten or twenty seconds that would take a competent locksmith or other safe expert **with full knowledge of the combination a minute or longer to open.**

High-grade safe combination locks, despite popular ballyhoo to the contrary, are not vulnerable to opening solely by "feel" or "sound" or "touch". Even a light standard three tumbler dial lock has **one million different combinations,** and while an expert can oftentimes open these with little trouble, he must use more mathematics than the average crook ever learned. He must know what the lock on that particular safe is like—he must know how to transpose what he feels or hears to what he knows of the interior of the lock. Needless to say, constant improvements in design and construction are making **clean openings** difficult even for the country's leading legitimate experts.

The author recently heard of a case where a college professor of mathematics bought a heavy **bullion safe** from a small town bank. The strongbox had been discarded when the bank was remodeled, and the cashier who had used it died while the safe lay empty, but locked, in the cellar. The lock, a four tumbler one made to withstand burglarious attack bespoke the possibility of **100,000,000 possible combinations.**

With the help of a safe and vault expert, the professor determined one number in the combination (the last one) and thereby reduced to 1,000,000 the combinations he was to try. He and a number of interested students made a list of all the possible combinations, and determined to try each of them. **After a year and three months** time and trying 59,000 combinations, they finally opened the safe.

46. CONSTRUCTION OF COMBINATION OR DIAL LOCKS

All combination locks depend on the same principles of construction. The amount of security offered depends entirely on the care and

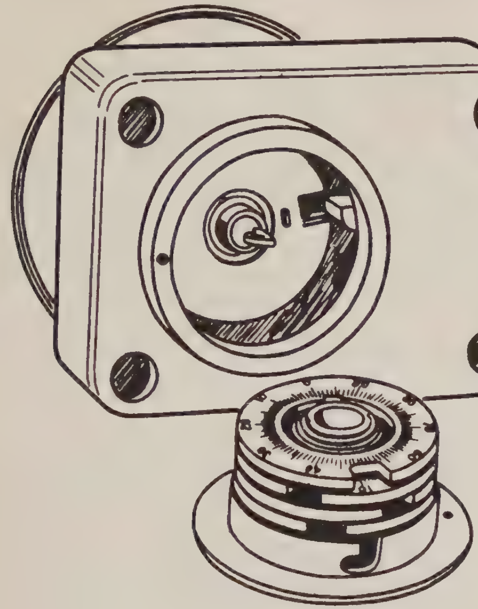


Illustration No. 77—A Modern 4-Tumbler Combination Lock

precision used in manufacturing. A roughly or loosely made lock naturally will not defy attack as efficiently as a tightly fitted accurately machined one.

The dial face (on which the numbers are

stamped) is fixed rigidly on a **spindle** which penetrates the thickness of the door and is attached to a **driving tumbler,** or flat, round wheel parallel to the dial. When the dial is turned, this driving tumbler turns with it, and by means of a post inserted in it, picks up and rotates a second tumbler, which in turn picks up a third etc. Each of these tumblers has a small notch cut in it, just large enough to accomodate the **fence,** which, when all three or four notches are lined up in the proper position, falls into the cavity thus created and thereby actuates the boltwork to release the door.

Dial or combination locks are regularly manufactured with as many as 100,000,000 different combinations, although **the average office safe has closer to 1,000,000.** Lighter safe locks are available with about 11,000 changes, and inexpensive drawer locks with considerably fewer than that.

Workmanship and quality of materials being equal, the security of a dial lock depends to a great extent upon the number of possible combinations to which it is adaptable. A lock with three tumblers, each tumbler being graduated for one hundred different **fence slot** positions has 1,000,000 combinations. This is obtained by raising the 100 to the 3rd power. A four tumbler lock, then, of similar type, would have 100,000,000 possibilities for changes, etc.

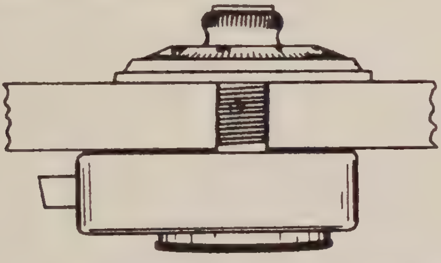


Illustration No. 78—Side View of Illus- tration No. 77

47. CHANGING COMBINATIONS AND REPAIRING DIAL LOCKS

Service work of any kind should never be attempted on combination locks by anyone not thoroughly acquainted with this branch of locksmithing. **This caution cannot be over-emphasized.** If a safe door is locked and the new combination won't work or the lock fails to operate, nobody can crawl in a window and save the day. A locksmith engaged in safe work accepts a great responsibility. Besides the inconvenience caused the customer, the danger to his own reputation, and possible legal restraint, a lockout on a safe or vault door can be very costly if some out-of-town expert must be imported to rectify a mistake.

Most new safes have combination instruction sheets attached to them. These should be read carefully for each lock, and never disregarded.

There are two general types of combination locks, hand changing and key changing. Although the hand changing is the simpler, it is in this kind that mistakes are most often made, since the tumblers must be removed from the lock to be adjusted. Be absolutely certain to return all the tumblers, spring rings and tension discs to the locks in exactly the same relative positions as they were originally.

The key changing lock was devised to eliminate the necessity of disassembling a lock to change the combination. On these locks, a special combination key is employed to unlock the tumblers from the spindle. The new combination is set to whatever numbers are desired while the changing key remains in the lock. After the key is turned back a half or a quarter turn to lock the tumblers in place, the safe should open on the combination to which it was set. **Never close or lock a safe door after a combination change until the new combination has been tried and actually operated at least three times without a single failure.** Disregard of this rule may easily result in a lockout.

The great advantage of the key changing combination lock is that it relieves the locksmith who changes the combination of any suspicion if some unauthorized person gets the combination. On this type of lock, the safe expert works at the back of the door, releasing the tumblers with the combination key. The person authorized to know the combination works the dial to form a new combination from his side of the door while the lock is in effect, out of gear. When the new numbers have been determined, the locksmith relocks the tumblers to the spindle by turning the key, and the customer tries the lock **with the door open.** If the new combination works three times without failure, the locksmith puts on the cover plate and the job is done. If any difficulty is encountered, he requests the customer to try a new combination.

Never lubricate a combination lock. Tension washers in these most intricate of mechanically operated devices are set to operate on friction alone, and if the friction is decreased, the lock may fail to operate properly.

Practically all combination lock manufacturers request that locksmiths do not attempt to make repairs in the field. This is not only for the customer's and the manufacturer's protection but for the protection of the locksmith involved.

A locksmith called upon to repair a burglarized safe should always **install a new lock,** not repair the old one. Most insurance companies insist on this, to avoid future claims, if another burglary takes place, that the lock was defective from previous battering. Combination locks are available in all large cities from safe and vault service departments of office outfitting houses, or may be ordered direct from factories under normal conditions.

48. PROTECTING SAFE LOCKS FROM ATTACK

Since combination locks are ordinarily built primarily for accuracy and combination security, they must be attached to the safe doors in such a way as to be protected as much as possible from forcible attack.

For this reason, many modern burglar resistant safes are made with what is known as a drive proof spindle, precluding the possibility of knocking off the exterior combination dial and driving the spindle and tumblers into the safe. **This method of forcible entry is known as punching.** The drive proof spindle is larger at the front of the door than it is at the inside, preventing its being driven through the door.

Another much used plan is to provide a lock with what is known as an **indirect or geared drive.** In this type of construction, instead of the lock tumblers being directly on the end of the spindle as described before, a simple toothed gear takes their place. This gear meshes with another gear attached to the drive tumbler, which is located in the lock case either to the right or left, or above or below the dial. The prospective yegg, then, **has no way of knowing where the lock case itself is located,** and consequently faces the necessity of cutting practically the whole door away in order to locate and attack the lock.

Another thing that decreases the possibilities of a successful attack by a criminal is the **automatic relocking device** with which almost every recently manufactured safe lock is now equipped. This consists usually of an auxiliary mechanism which jams the boltwork even if the lock itself is rendered useless. Thus a safecracker who destroyed the combination lock would only succeed in locking himself out more securely than ever, since a relocking mechanism is not constructed so as to be operated from the outside except by factory trained service experts, equipped with special tools.

49. TIME LOCKS

Time locks operate exclusively by clockwork, depending neither on combination nor keys for control. Usually at least three clocks are set in a series, any one of which will individually operate the lock. Thus, if one stops and one is put out of service by an accident, such as a slight earthquake, there is still one left to actuate the lock.

They are known as 72 or 96 hour clocks, depending upon the number of hours their opening may be delayed. Locks of this type **should never, under any circumstances, be touched by**

anyone not entirely familiar with their operation. Repairs and adjustments are generally made by factory representatives, usually on a contract basis. These men are not only master locksmiths, **but must also be qualified jewelers or watchmakers** to properly adjust, repair, and clean the delicate clockwork.

50. VAULT LOCKS

Safe-deposit, specie, and currency vaults in present day banks are almost universally controlled by a combination of two types of locks already mentioned.

Dial locks are installed in conjunction with the time lock, so that the vault can be opened only when certain authorized bank officials are present to operate the combination. The time lock, for its contribution to security, keeps these men, or anyone else, from opening the vault at night or on holidays. This plan precludes the possibility of bandits kidnapping a bank officer or several bank officials and forcing them to open the locked vault. Signs, in many cases, are publicly displayed in banks to notify all persons of this double protection, thus saving employees from possible mistreatment or torture by armed bandits.

51. MULTIPLE CUSTODY LOCKS

Another plan for increasing the security of a vault is to **distribute the combination to three or four persons,** making it necessary for all to be present at every opening, since each knows only his part of the combination. This is known as the **multiple custody system,** and relieves an individual employee of a great deal of worry and responsibility.

The largest users of the **double custody** principle are of course the safe deposit companies.

SAFE DEPOSIT BOX LOCKS

Locks used on safe deposit boxes differ from any other locks in two ways. First they require two separate and distinct keys to operate them, that of the renter or user, and that of the guard or bank attendant. **Both must be used, simul-**

taneously in most cases, to open each individual box.

In the second place, notwithstanding warnings to the contrary by writers certainly not qualified as lock experts, safe deposit box locks are not made so that any master key or pass key will fit any of them. Each lever lock of this type has from five to eight or ten tumblers depending on the size of the vault, each tumbler having five or six more different depth possibilities. A fair average would be six and six, or 46,656 different key changes for a light six lever lock. Since every bank's guard or preparatory key is different and each vault has no two locks keyed alike, there is little danger of unauthorized entry, especially since most safe deposit firms require signature identification before the renter is even admitted to the vault.

52. "TIMBINATION" LOCKS

One of the latest innovations in bank and safe locks is the timbination lock announced by one of the leading manufacturers of safe locks.

Essentially, it consists of a combination lock with a double movement timing arrangement to delay opening of the lock for from five to thirty minutes, and is intended for use where such a feature is desired to prevent daylight holdups or forced operation under threat.

Assume for instance, that a jeweler finds an armed bandit waiting for him when he opens the store in the morning. Forced at the point of a gun to open the safe, he does so, but the timing device keeps the door closed for thirty minutes after the lock is opened. The bandit will probably leave rather than wait half an hour, since he knows a secret alarm may have been turned in, and that other employees and customers will soon be entering the building.

53. THE LOCKSMITH IN AN ADVISORY CAPACITY

Many locksmiths have regular customers among business firms who pay fancy prices for insurance, income tax advice, and legal aid. Quite often a locksmith can serve in the capacity of an adviser **and be well paid for it.**. Probably at least five of the following rules for security of the contents of a safe are disregarded in most offices. Locksmiths who notice these possibilities for loss can command excellent fees for suggestions to correct them.

1. Never write a safe combination anywhere an unauthorized person can get at it. Write it on a card and put it in your safe deposit box for your own protection in case of loss of memory or death.
2. Change the combination without fail **immediately** upon discharging a person to whom you have given the combination, or if you have reason to believe someone has somehow gotten it.
3. Always stand in front of a safe when operating the combination. Standing to the side to get better light may give the combination to anyone near by. Safe robbers have even been known to watch with field glasses from windows across the street.

4. Never store cash or valuables in a safe intended solely for **fire protection.** These boxes are not intended to be burglar proof, and in many cases are not even **burglar resistant.** Anchor a **burglar proof chest** to the bottom of your fire safe if you customarily store large amounts of cash overnight.

5. Never place a safe containing cash or articles of great value against a back or side wall. Better to have it near the front of the store where it can be easily seen from the street. Too often a jeweler has opened his safe to find the contents missing, the thieves having entered an adjoining store and cut the back of the safe away without disturbing his intricate burglar alarms.

6. Don't have safe combinations set to match numbers in your house address, telephone numbers, or license plates. Other people have phone directories, too.

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